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TRANSCRIPT OF RECORD.

SUPREME COURT OF THE UNITED STATES.

OCTOBER TERM, 1885.

No. 208.

WINFIELD SCOTT KEYES AND ALBERT ARENTS,
PLAINTIFFS IN ERROR,

vs.

JAMES B. GRANT AND JAMES GRANT.

IN ERROR TO THE CIRCUIT COURT OF THE UNITED STATES FOR THE DISTRICT OF COLORADO.

FILED MARCH 20, 1883.

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1 Pleas in the Circuit Court of the United States for the District of Colorado, sitting at Denver.

Be it remembered that heretofore, and on, to wit, the 3d day of November, A. D. 1880, came Winfield Scott Keyes and Albert Arents, by Messrs. Symes and Foot, their attorneys, and filed in said court their complaint, and sued out of and under the seal of said court a writ of summons against James B. Grant and James Grant; and the said complaint is in words and figures as follows, to wit:

Complaint.

In the Circuit Court of the United States in and for the Eighth Circuit, District of Colorado.

WINFIELD SCOTT KEYES and ALBERT ARENTS, Plaintiffs,
against
JAMES B. GRANT and JAMES GRANT, Defendants.

Now comes the above-named plaintiffs, Winfield Scott Keyes, a resident of the State of California, and Albert Arents, a resident of the State of Colorado, and complain of the above-named defendants, James B Grant, a resident of the State of Colorado, James Grant, a resident of the State of Iowa, and for cause of action allege—

I. That said plaintiffs are now, and were, before and at the time of the making and issuing of the letters patent hereinafter mentioned, the true, original, and first inventor of a certain new and useful improvement in furnaces for smelting lead and other ores, which was not known or used before such invention and discovery as aforesaid, and was not at the time of the plaintiffs' applica-
2 tion for letters patent, as hereinafter mentioned, in public use or on sale with the consent or allowance of plaintiffs, or either of them; and that said plaintiffs, being such original and first inventors, obtained for such invention letters patent of the United States bearing date the 28th day of November, 1871, which letters patent were under the seal of the Patent Office of the United States, signed by the Secretary of the Interior and countersigned by the Commissioner of Patents, and did grant according to law to said plaintiffs, their heirs and assigns, for the the term of seventeen years from said twenty-eighth day of November, 1871, the full and exclusive right and liberty of constructing and using, and vending to others to be used, the said improvement, a description whereof was and is given in the words of said plaintiffs in a certain specification to said letters patent annexed and made part thereof, as by reference to said letters patent and the said specification thereto annexed, which plaintiffs now produce and bring into court, will more fully appear.

II. And plaintiffs further allege that from the time of the granting to them of said letters patent hitherto they have made and used, and vended to others to be used, the said improvement to their advantage and profit.

III. That the said defendants, who were copartners in business

doing business in this State under the firm name and style of J. B. Grant & Co., at the time hereinafter mentioned, well knowing the premises and contriving to injure the plaintiffs, did, on or about the 1st day of September, 1878, and on or about the 1st day of February, 1879, and at divers other times, before and afterwards, during the said term of seventeen years mentioned in the said letters patent, and before the commencement of this action in Lake county, in the State of Colorado, unlawfully and wrongfully, and without the consent or allowance and against the will of plaintiffs, use and
3 cause to be used the said improvement in violation and infringement of the exclusive right so secured to plaintiffs by said letters patent aforesaid contrary to the form of the statute of the United States in such case made and provided, whereby the plaintiffs have been greatly injured and deprived of great profit and advantage which they would otherwise have derived from said improvement, and have sustained actual damage to the amount of nine thousand dollars ($9,000.00), and by force of the statute aforesaid an action has accrued to them to recover the said actual damage, and such further amount not exceeding in the whole three times the amount of such actual damage as the court may see fit to order and adjudge, besides costs.

IV. That defendants, though often requested, have never paid the same, or any part thereof, to the plaintiffs, or either of them, but have refused, and yet refuse, so to do, and no part of said damages has been paid, wherefore plaintiffs pray judgment against said defendants; that plaintiffs may be awarded damages against them in the sum of nine thousand dollars, and that judgment may be entered against them in favor of plaintiffs for three times the amount of such damages, together with plaintiffs' costs.

(S'g'd) SYMES & FOOT,
Att'ys for Plaintiffs.

STATE OF COLORADO, }
County of Arapahoe, } *ss:*

Albert Arents, being duly sworn, says: That he is one of the plaintiffs in this action; that he has read the foregoing complaint, and knows the contents thereof, and that the same is true of his own knowledge, except as to the matters therein stated on infor-
4 mation and belief, and as to those matters he believes it to be true.

(S'g'd) ALBERT ARENTS.

Subscribed and sworn to before me, this 30th day of Oct., 1880.
(S'g'd) L. L. BEDELL,
Justice of the Peace, Summit Co., Colo.

Endorsed: No. 613. U. S. circuit court, district of Colorado. Winfield Scott Keyes *et al. vs.* James B. Grant *et al.* Complaint. Symes & Foot, for pl'ffs. Filed Nov. 3, 1880. (S'g'd) Edward F. Bishop, clerk.

And the said summons is in words and figures as follows, to wit:

Summons.

5 In the Circuit Court of the United States for the District of Colorado.

UNITED STATES OF AMERICA, } ss:
District of Colorado, }

Complaint filed in the clerk's office this 3d day of November, A. D. 1880.

WINFIELD SCOTT KEYES and ALBERT ARENTS, Plaintiffs,
versus
JAMES B. GRANT and JAMES GRANT, Defendants.

The President of the United States of America to James B. Grant and James Grant, Greeting:

You, and each of you, are hereby notified that an action has been brought in said court by Winfield Scott Keyes and Albert Arents, plaintiffs, against you as defendants, to recover $9,000.00 damages due by you, the said defendants, to the said plaintiffs for the unlawful and wrongful use of a certain patented improvement in furnaces for smelting lead and other ores, owned by said plaintiffs, and as more particularly set out and described in the complaint filed herein and to which reference is hereby made, and for the costs of this suit.

You are hereby required to appear and demur or answer to the complaint filed in said action, in said court, within ten days (exclusive of the day of service) after this summons shall be served on you, if such service shall be made within the county of Arapahoe; otherwise, within forty days from the day of service; and if you fail so to do, the said plaintiffs will take judgment against you by default, according to the prayer of the said complaint, for the said sum of $900.00 and costs of suit.

Witness the Honorable Morrison R. Waite, Chief Justice of the Supreme Court of the United States, and the seal of the said circuit court at the city of Denver, in said district, this third day of November, A. D. 1880, and of the Independence of the United States the 105th year.

[Seal Circ't Ct. U. S., Colo.]

(S'g'd) EDWARD F. BISHOP, *Clerk.*
By F. W. TUPPER, *Deputy Clerk.*

6 *Proof of Service.*

UNITED STATES OF AMERICA, } ss:
District of Colorado, }

LEADVILLE, COLO., *Nov.* 22, *A. D.* 1880.

I hereby certify that I received the within writ on the 8th day of November, A. D. 1880, and that I have personally served the same upon James B. Grant, one of the said defendants, by delivering to him

personally a true copy of the within writ, at the day and time as follows: At Leadville, county of Lake, on the 8th day of November, A. D. 1880. As to James Grant served by personally delivering a certified copy of the within to James B. Grant, brother of the said James Grant, who accepted service for him. Served at Leadville, Lake county, Colorado, Nov. 8th, A. D. 1880.

This writ therefore returned served, as the law directs, this 23d day of November, A. D. 1880.

(S'g'd) P. P. WILCOX, *Marshal*,
By B. AYRES,
Deputy Marshal.

Endorsed: Gen. No. 613. Circuit court of the United States for the district of Colorado. Winfield Scott Keyes and Albert Arents, plaintiffs, *versus* James B. Grant and James Grant, defendants. Summons. Filed this 23d day of Nov., A. D. 1880. (S'g'd) Edward F. Bishop, clerk, by F. W. Tupper, deputy clerk. Symes & Foot, Denver, attorney- for plaintiff-.

7 And afterwards, and on, to wit, the 12th day of January, A. D. 1881, came the said defendants, by James Grant, Esq., their attorney, and filed in said court and in said cause their answer to the complaint heretofore filed herein. And the said answer is in words and figures as follows, to wit:

Answer. Pleas of Defendant.

Circuit Court of the United States for the District of Colorado.

WINFIELD SCOTT KEYES & ALBERT ARENTS
vs.
JAMES B. & JAMES GRANT.

Now comes the said defendants, by Grant & Grant, their attorneys, and for answer to said petition, say:

1. The defendants deny that the plaintiffs were ever at any time before the issue of the letters patent, referred to in their petition, the original and first inventors of a certain new and useful improvement for the smelting of lead ores, which was not known at the time of said alleged discovery, and which was not at the time of said alleged application in public use or on sale, with the consent of said plaintiffs or either of them.

2. These defendants admit the issuance of said letters patent on 28 Nov., 1871, referred to in the petition, but insist that a copy of the same should be annexed to the plaintiffs' petition.

3. The defendants deny that from the date of the letters patent the plaintiffs have made, vended, and used said improvement.

4. The defendants admit that they were partners from about 1st Sept., 1878, to 1 January, 1880. They deny that, well
8 knowing the premises, and contriving to injure the plaintiffs, they did on or about 1st Sept., 1878, or at any other time up to Feb, 1879, or at divers times, before and after, during the term of seventeen years from the date of said patent, and before the com-

mencement of said suits in said Lake county, & State, unlawfully and wrongfully and without the consent of the plaintiffs use, and cause to be used said improvement, in violation and infringement of the exclusive rights of said plaintiffs, contrary to the form of the statute, to their injury in said sum of $9,000 or any other sum.

4. And for further defense to said action these defendants aver that after said alleged discovery, and before and after the date of said letters patent, the said alleged improvement had been in public use with the knowledge and permission of said patentees for such time that their exclusive right, if any, they had, was abandoned.

5. For a further defense to said action the defendants say that said alleged improvement of Keyes & Arents was patented by the United States, by letters patent issued to one William McFarland, & dated the 7 of December, 1858, prior to the date of the patent to Keyes & Arents.

6. And for a further defense the defendants aver that said alleged improvements and invention has been in use in what is called the forehearth of blast furnances, for twenty years prior to the date of said patents, in iron furnaces all over the United States.

7. They allege that said alleged improvement of tapping from the bottom of a furnace, so that the metal should run clear and free from impurities, has been in use in iron furnace of Michael Donahoe, in the city of Davenport, Iowa, from and since the year 1860.

9 8. These defendants further aver that George W. Lee, now of Capital City, Colorado, in 1866 & prior thereto, in lead smelting furnaces at Mine La Matte and Japlin, Missouri, and the said alleged improvement in tapping ores from the bottom of the furnace in the same manner as now claimed by the plaintiffs.

9. That the same was in use at said Mine La Motte by ———, prior to the date of said alleged discovery and improvement. That the same alleged improvement was used by E. K. Moffitt and his associates at Japlin, Missouri, from the year 1866 to this date, by divers other smelters in Illinois and Missouri, whose names are unknown to the defendants.

10. That the said alleged invention was in use at lead smelting works at St. Joseph, Missouri, by ———, prior to the date of the alleged discovery by the plaintiffs.

11. And for a further defense to said action these defendants say that said alleged improvement, called the automatic or siphon tap, was, prior to the date of said patent, in the following publications or books published in foreign countries, viz: In John Percy's Metallurgy of Lead, 1 volume, published in London, England, by John Murry, in 1870, pages 418, 419, & 420. And the same priority of publications is repeated by John Percy in his book on Silver & Gold, 1 volume, published by John Murray, in London, England, in 1880, pages 549, 550, & 551. That the said alleged improvement is also described in Carsten's System der Metallurgie, vol. 5, page 166, & atlas figure 860, published in the year 1832, at Berlin, in Prussia. The same is also published & described in volume 1, part 2, page 57, & volume 1, of Lampadius Hand Buck der All-

10 geimine Hütler Kunder, published at Gütluigen, in Germany,

in 1805. The same is also described in John Barthe's Technical Chemistry, 2d edition, vol. 1, page 183, plate XI, figure 20, published in Berlin, Prussia, in 1835. The same is also published & described in the 3d volume of Watts' Chemical Dictionary, pages 489, 490, & 491 & following, published in London in 1868.

Wherefore the defendants ask judgment if the plaintiffs ought further to have and maintain their aforesaid action.

(S'g'd) GRANT & GRANT,
For Def'ts.

STATE OF MASS., *County of Suffolk:*

I, James Grant, one of the above-named defendants, being duly sworn, declare on oath that I believe all the allegations of the foregoing answer to be true.

(S'g'd) JAMES GRANT.

STATE OF MASSACHUSETTS, *County of Suffolk:*

Be it known that on the fourth day of Jan'y, 1881, came before me, a notary public in and for said county and State, James Grant, who, being duly sworn, declared on oath that he believed the allegations of the foregoing answer to be true.

Given under my hand and seal notarial the date above written.

[Seal Notarial.] (S'g'd) HALES W. SUTRO,
Notary Public.

Endorsed: No. 613. Keyes & Arents *vs.* Grant & Grant. Action at law. Answer. Filed Jan. 12, 1881. (S'g'd) Edward F. Bishop, clerk. Grant & Grant, att'ys.

11 And afterwards, and on, to wit, the 18th day of January, A. D. 1881, came again the said plaintiffs, by their attorneys aforesaid, and filed in said court and in said cause their replication and demurrer to the answer of the defendants hertofore filed herein. And the said replication and demurrer is in words and figures as follows, to wit:

Replication and Demurrer to Answer.

Circuit Court of the United States for the District of Colorado.

WINFIELD SCOTT KEYES and ALBERT ARENTS
vs.
JAMES B. and JAMES GRANT.

Replication.

The plaintiffs, by Symes & Foot, their attorneys, reply to the separate defences of the defendants herein as follows, to wit:

1. They deny that after the alleged discovery of the plaintiffs, and before and after the date of their letters patent, the said alleged improvement has been in public use, with the knowledge and permission of said patentees, for such time that their exclusive right, if any they had, was abandoned.

2. They deny that said alleged improvement and invention has been in use in what is called the forehearth of blast furnaces for twenty years prior to the date of said patent in iron furnaces all over the United States.

3. They deny that said alleged improvement of tapping from the bottom of a furnace, so that the metal should run clear and free from impurities, has been in use in iron furnaces of Michael Donahue, in the city of Davenport, Iowa, from and since the year 1860.

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4. They deny that George W. Lee, now of Capital City, Colorado, in 1866, and prior thereto, in lead smelting furnaces at mine La Motte, and Joplin, Missouri, used the said alleged improvement on tapping ores from the bottom of the furnaces in the same manner as now claimed by the plaintiffs.

5. They deny that said alleged improvement was prior to the date of said patent in following publications or books, published in foreign countries, viz: In John Percy's Metallurgy of Lead, 1 volume, published in London, England, by John Murry in 1870, pages 418, 419, & 420.

6. They deny that the same priority of publication is repeated by John Percy in his book on Silver & Gold, 1 volume, published by John Murry, in London, England, in 1880, pages 549, 550, & 551.

7. They deny that said alleged improvement is also described in Cursten's System Der Metallurgie, vol. 5, page 166, and atlas figure 860, published in the year 1832, at Berlin, in Prussia.

8. They deny that the same is also published and described in vol. 1, part 2, page 57, and following of Lampadius Hand Buch der Allgeimeine Hütler Kunder, published at Göttingen, in Germany, in 1805.

9. They deny that the same is also described in Schubarth's Technical Chemistry, 2d edition, volume 1, page 133, plate XI, figure 20, published in Berlin, Prussia, in 1835.

10. They deny that the same is also published and described in the 3d volume of Watts' Chemical Dictionary, page- 489, 490, & 491 and following, published in London in 1868.

And to the separate defences of the defendant, hereinafter referred to, the plaintiffs demur, and for ground of demurrer state:

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1. That the defence of the defendants set forth in the fifth paragraph of their answer is insufficient in this—said defence of prior invention does not state—

1. When the letters patent therein alleged to have been issued to one William McFarland were issued.
2. Said defence does not state the residence of said William McFarland as by law required.

2. That the defence of the defendants set forth in the ninth paragraph of their said answer is insufficient in this—that the name of the person alleged to have used said discovery and improvement is not given, and for the further reason that the names of the associ-

ates of E. K. Moffet, therein alleged, are not given, and for the reason further that the names of divers others therein referred to are not given.

3. That the defence of the defendants set forth in the 10th paragraph is insufficient in this—that the name of the person alleged to have used said discovery and improvement is not given.

(S'g'd) SYMES & FOOT,
Att'ys for Plaintiffs.

Endorsed: 613. Circuit court U. S. W. S. Keyes *et al. vs.* J. B. Grant *et al.* Replication and demurrer. Filed Jan. 18, 1881. (S'g'd) Edward F. Bishop, clerk. Symes & Foot, att'ys for pl'ffs.

14 And afterwards, and on, to wit, the 28th day of February, A. D. 1881, came again the said defendants, by their attorneys aforesaid, and filed in said court and in said cause their amendment and addition to the answer heretofore filed herein; and the said amendment and addition is in words and figures as follows, to wit:

Amendment and Addition to Answer.

In United States Circuit Court, District of Colorado.

KEYES & ARENTS *vs.* J. B. GRANT & Co.

Amendment & Addition to Answar.

The said defendants, by consent of plaintiffs, make the following amendments and additions to their answer:

1st. McFarland's patent is dated on and was issued on 7th December, 1858, and he was a citizen of St. Louis, Missouri.

2d. These defendants further state that in the year 1867 and before that time and prior to the date of the plaintiffs' patent or alleged discovery a furnace with the alleged improvement claimed by the plaintiffs was erected & operated at Argenta, in Montana, by the St. Louis and Montana Mining Company. The furnace was built under the superintendence of one Augustus Steits, now dead, and one B. T. Tilden, now of Boston, Massachusetts, was a foreman of said company and operated said furnace for said company.

3d. These defendants further aver that on the 12th of May, 1863, a patent for the alleged invention of the plaintiffs was issued and delivered by the United States to James F. Stillman and
15 Zahna Ellis, of Philadelphia, Pa.

Wherefore defendants ask judgment if the plaintiffs ought further to have and maintain their action, &c.

(S'g'd) GRANT & GRANT,
Atty's for Def'ts.

STATE OF MASSACHUSETTS, }
County of Suffolk, } *ss:*

I, James Grant, being duly sworn on oath, say: That I am one of the defendants in the above-entitled suit; that I have read the fore-

going amendment and addition to the answer of defendants herein, and the allegations thereof are true, as I verily believe.

(S'g'd) JAMES GRANT.

Subscribed and sworn to by James Grant, this 19th day of February, 1881. Given under my hand, seal notarial, a notary public for the county of Suffolk, Mass.

[Seal Notarial.] (S'g'd) CHAS. MERRIAM,
Notary Public.

Endorsed: 613. U. S. cir. court, district of Colorado. Keyes *et al.*, *vs.* Grant *et al.* Amendment and addition to answer. Filed Feb. 28, 1881. (S'g'd) Edward F. Bishop, clerk. Grant & Grant, atty's for def'ts.

And afterwards, and on, to wit, the 28th day of February, A. D. 1881, came again the said plaintiffs, by their attorneys aforesaid, and filed in said court and in said cause their reply to the amended and additional answer theretofore filed herein. And the said reply is in words and figures as follows, to wit:

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Reply to Amendment to Answer.

United States Circuit Court for the District of Colorado.

WINFIELD SCOTT KEYES and ALBERT ARENTS
against
JAMES B. and JAMES GRANT.

The plaintiffs, by Symes & Foot, their attorneys, reply to the amendments and additions to the answer of the defendants filed herein on the 28th Feb'y, 1881, as follows, to wit:

1. They deny that in the year 1867, or at any time prior to the plaintiffs' patent or discovery, the improvement claimed by the plaintiffs was erected and operated at Argenta, in Montana, by the St. Louis and Montana Mining Company by any person or persons whatsoever.

2. And for a more complete and full denial to the answer of the defendants, and their amendments and additions thereto, these plaintiffs say that at no time whatsoever, prior to the date of the patent of the plaintiffs was the improvement or invention of the plaintiffs used by any person or persons whatsoever, in, at, or near any place or places whatsoever, or in any manner whatsoever in public use in connection with any furnace or furnaces, or any device or devices whatsoever.

3. They deny that on the 12th May, 1863, or any time letters patent were issued for the invention of the plaintiffs, and delivered by the United States to James F. Stillman and Zahn Ellis, of Philadelphia, Pa.

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(S'g'd) SYMES & FOOT,
Atty's for Pl'ff.

Endorsed: 613. United States circuit court, district of Colorado. Winfield Scott Keyes and Albert Arents *vs.* James B. and James

Grant. Reply to amended answer and additions. Filed Feb. 28, 1881. (S'g'd) Edward F. Bishop, clerk. Symes and Foot, att'ys for pl'ff.

And afterwards, and on, to wit, the 16th day of March, A. D. 1881, came again the said defendants, by their attorneys aforesaid, and filed in said court and in said cause their further amendment and addition to the answer heretofore filed herein. And the said further amendment and addition to answer is in words and figures as follows, to wit:

Further Amendment and Addition to Answer.

Circuit Court of the United States, District of Colorado.

WINFIELD SCOTT KEYES and ALBERT ARENTS
vs.
JAMES B. GRANT and JAMES GRANT.

Further Amendment to Answer.

The defendants make this further amendment and addition to
18 their answer: That the Detroit and Lake Superior Copper Company, in 1865 or 1866, at Detroit, Michigan, where the company then did business, and afterwards at Houghton, on Lake Superior, Michigan, in 1870, used and operated the alleged improvement & invention claimed by plaintiffs prior to the date of their patent on 28 Nov., 1871. Wherefore the defendants pray judgment.

(S'g'd) GRANT & GRANT,
For Defendant-.

Endorsed: 613. U. S. cir. c't. dist. of Colorada. Keyes & Arents *vs.* Jas. B. & Jas. Grant. Further amendment and addition to answer. Filed Mar. 16, 1881. (S'g'd) Edward F. Bishop, clerk; G. & G., for Def't.

And afterwards and on, to wit, the 16th day of March, A. D. 1881, came again the said plaintiffs, by their attorneys aforesaid, and filed in said court and in said cause their reply to the further amendments to the answer heretofore filed herein. And the said reply is in words and figures as follows, to wit:

Reply to Further Amendments to Answer.

Circuit Court of the United States of Colorado.

WINFIELD SCOTT KEYES and ALBERT ARENTS
against
19 JAMES B. GRANT and JAMES GRANT.

The plaintiffs, by Symes & Foot, their attorneys, in reply to the further amendment and addition to answer of defendants, deny that the Detroit and Lake Superior Copper Company, in 1865 or in 1866, or at any time, at Detroit, Michigan, or at any place, or afterwards, at Houghton, on Lake Superior, Michigan, in

1870, or at any place or at any time afterwards, used and operated the improvement and invention of the plaintiffs claimed by their patent dated Nov. 28, 1871.

(S'g'd) SYMES & FOOT,
Att'y for Plaintiffs.

Endorsed: 613. U. S. circuit court. Winfield Scott Keyes and Albert Arents *vs.* James B. Grant *et al.* Reply to further amendment of answer. Filed Mar. 16, 1881. (S'g'd) Edward F. Bishop, clerk. Symes & Foot, att'ys for pl'ff-.

And afterwards, and on, to wit, the 1st day of April, A. D. 1881, came again the said defendants, by their attorneys aforesaid, and filed in said court and in said cause their third amendment and addition to the answer heretofore filed herein. And the said third amendment and addition is in words and figures as follows, to wit:

3d Amendment and Addition to Answer.

20 In the U. S. Circuit Court, District of Colorado.

WINFIELD SCOTT KEYES and ALBERT ARENTS
vs.
JAMES B. GRANT and JAMES GRANT.

Third Amendment and Addition to Answer.

Now come defendants in the above cause, and, for a third amendment and addition to their answer, state that the alleged improvement of plaintiff- was prior — the date of said patent described on pages 495 & 496 of Watts' Dictionary of Chemistry, volume III, published in London, England, in 1868. Wherefore defendants pray judgment.

(S'g'd) GRANT & GRANT,
For Defendants.

Endorsed: 213. In U. S. cir. c't, dist. of Colorado. Keyes & Arents *vs.* J. B. Grant & Co. 3d amendment and addition to answer. Filed Apr. 1, 1881. (S'g'd) Edward F. Bishop, clerk. Grant & Grant, for def't.

And afterwards, and on, to wit, the 1st day of April, A. D. 1881, came again the said plaintiffs, by their attorneys aforesaid, and filed in said court and in said cause their reply to the third amendment and addition to answer, and the said reply is in words and figures as follows, to wit:

Reply to Third Addition and Amendment to Answer.

21 In the U. S. Circuit Court, District of Colorado.

WINFIELD SCOTT KEYES *et al. against* JAMES B. GRANT *et al.*

The plaintiffs, by way of reply to the defendants' third amendment and addition to their answer, state: They deny that the alleged improvement or improvement of the plaintiffs was prior to the date

of their patent, or at any time described in pages 495 and 496, or on any page or pages of Watts' Dictionary of Chemistry, volume III, or any volume of said work published in London, England, in 1868.

(S'g'd) SYMES & FOOT,
For Pl'ffs.

Endorsed: 613. U. S. circuit court. Winfield Scott Keyes *et al. vs.* James B. Grant *et al.* Reply of pl'ffs to def'ts 3- amendment to answer. Symes & Foot, pl'ffs att'ys. Filed Apr. 1, 1881. (S'g'd) Edward F. Bishop, clerk.

And afterwards, and on, to wit, the 9th day of May, A. D. 1881, the same being one of the regular juridical days of the May term, A. D. 1881, of said court, present the honorable Moses Hallett, district judge, the following proceeding was had and entered of record in said court and said cause, to wit:

22 *Order. Defendants granted Leave to again Amend Answer. For Damages.*

WINFIELD SCOTT KEYES and ALBERT ARENTS
vs.
JAMES B. GRANT and JAMES GRANT.

At this day come the said plaintiffs, by R. E. Foot, Esq., their attorney, and the said defendants, by James Grant, Esq., their attorney, also come. And thereupon, on their motion, it is ordered that the said defendants have leave to again amend their answer as they shall be advised.

And afterwards, and on the same day, to wit, the 9th day of May, A. D. 1881, the following further proceeding was had and entered of record in said court and in said cause, to wit:

Order. Exceptions to Interrogatories to Howell Overruled. For Damages.

WINFIELD S. KEYES *et al. vs.* JAMES B. GRANT *et. al.*

At this day come the said plaintiffs, by R. E. Foot, Esq., their attorney, and the said defendants, by J. B. Grant, Esq., their attorney, also come. And the exceptions of the said defendant to the interrogatories of the said plaintiff to M. D. Howell, coming on now to be heard, and the court being now sufficiently advised in the premises, it is ordered by the court that the said objections be overruled. And thereupon, as well the plaintiffs as the said defendants now here consenting thereto, it is ordered that the said plaintiffs have leave to withdraw permanently from the files herein their interrogatories to Keyes, Christy Howell, Didesheimer, and
23 Brown; and the said defendants have leave to withdraw their cross-interrogatories to said parties.

And afterwards, and on, to wit, the 9th day of July, A. D. 1881, came again the said defendants, by James Grant, Esq., and Messrs.

Wells, Smith, and Macon, their attorneys, and filed in said court and in said cause their amendment to the answer heretofore filed herein.

Amendment to Answer.

United States, District of Colorado. In the Circuit Court.

WINFIELD SCOTT KEYES, ALBERT ARENTS,
vs.
JAMES GRANT, JAMES B. GRANT.

And the said defendants, by leave of the court here further amend their answer herein by inserting in said answer, next before the signature thereto, in words and figures as follows, to wit:

"Also, as defendants are informed and believe, and therefore aver, in Kerl's Oberharzen Hütten Processe, Plate III. Published at Clausthal, Germany, by Grost, in the year 1860."

(S'g'd) JAMES GRANT.
" WELLS, SMITH & MACON,
Attorneys.

United States, District and State of Colorado, Arapahoe County.

E. T. WELLS, being first duly sworn, saith on oath that he is one of the attorneys of the above-named defendant; that
24 neither of the said defendants reside in or are present at the said county of Arapahoe, where deponent resides.

That he hath read the foregoing amendment to the answer of the said defendants and knows the contents thereof, and the same is true as he verily believes; that this verification is made by deponent because of the non-residence and absence of both the defendants from the county, as above set forth.

(S'g'd) E. T. WELLS.

Subscribed and sworn to before me, this 9th day of July, A. D. 1881.

[Seal Dist. Ct. U. S., Colo.]
(S'g'd) EDWARD F. BISHOP, *Clerk*,
By F. W. TUPPER,
Deputy Clerk.

Endorsed: 613 Circuit court U. S. W. S. Keyes *et al. vs.* J. B. Grant *et al.* Amendment to answer. Filed Jul. 9, 1881. (S'g'd) Edward F. Bishop, clerk.

And afterwards, and on, to wit, the 11th day of July, A. D. 1881, came again the said plaintiffs, by their attorneys aforesaid, and filed in said court and in said cause their demurrer to amended answer lastly filed herein; and the said demurrer is in words and figures as follows, to wit:

Demurrer to Amendment to Answer.

United States District Court.

25 WINFIELD SCOTT KEYES, ALBERT ARENTS
vs.
JAMES GRANT and JAMES B. GRANT.

Demurrer to 5th Amendment to Answer.

Now come the plaintiffs by Symes & Foot, their attorneys, and demur to the fourth (4th) amended answer of the defendants, and for ground of demurrer state that the said amendment does not state facts sufficient to constitute a defence.

(S'g'd) SYMES & FOOT,
For Plaintiffs.

Endorsed: 613. United States circuit court. Winfield Scott Keyes *et al. vs.* James Grant *et al.* Demurrer of pl'ff- to 4th amended answer. Symes & Foot, for pl'ffs. Filed Jul. 11, 1881. (S'g'd) Edward F. Bishop, clerk.

And afterwards, and on, to wit, the 16th day of July, A. D. 1881, the same being one of the regular juridical days of the May term, A. D. 1881, of said court, present, the honorable Moses Hallett, district judge, the following further proceeding was had and entered of record in said court and in said cause, to wit:

26 *Order. Defendants granted leave to withdraw 4th Amended Answer and to Answer again. For Damages.*

WINFIELD SCOTT KEYES *et al. vs.* JAMES B. GRANT *et al.*

At this day come the said plaintiffs by R. E. Foot, Esq., their attorney, and the said defendants, by Thomas Macon, Esq., their attorney, also come. And thereupon, on motion of the said defendants, the said plaintiffs now here in open court consenting thereto, it is ordered by the court that the said defendants have leave to withdraw permanently from the files herein the fourth amended answer filed herein and to answer again as they shall be advised.

And afterwards, and on the same day, to wit, the 16th day of July, A. D. 1881, came again the said defendants by their attorneys and filed in said court and in said cause their fourth amendment to the answer heretofore filed herein. And the said amendment is in words and figures as follows, to wit:

Copy.

Fourth Amendment to Answer.

In the Circuit Court of the United States, District of Colorado.

WINFIELD SCOTT KEYES and ALBERT ARENTS
vs.
JAMES B. GRANT and JAMES GRANT.

Fourth Amendment and Addition to Answer.

Now come the defendants in the above-entitled cause and, by leave

of court first had & obtained, make this fourth amendment & addition to their answer. They state that the alleged improvement of plaintiffs in smelting furnaces was, prior to the date of their said alleged patent, published in Karsten's System der Mettal-
27 lurgie, pages 150 to 166, inclusive, and pages 166 to 180, inclusive, volume 5, and in his Atlas tab. XLI, figures 850 to 867, inclusive, published in Berlin, Prussia, in the year 1832. That prior to the date of said patent the said improvement was described in Watt's Chemical Dictionary, vol. 3, on pages 495 & 496, published in London, England, in 1868.

Wherefore defendants ask judgment if the plaintiffs ought further to have and maintain their aforesaid action.

GRANT & GRANT,
For Defendants.

STATE OF IOWA, } ss:
Scott County, }

I, James Grant, one of the above-named defendants, being duly sworn, declare on oath that I believe all the allegations of the above amendment to be true.

(Signed) JAMES GRANT.

STATE OF IOWA, } ss:
County of Scott, }

Be it known that on the — day of April, 1881, came before me, a notary public in and for said county & State, James Grant, who, being duly sworn, declared on oath that he believed all the allegations of the foregoing amendment to be true.

Witness my hand & notarial seal, the date last above written.

[SEAL.] (S'g'd) A. M. ACTON,
Notary Public, Scott Co., Iowa.

Plaintiffs have ten days from date to answer without verification. July 16, 1881.

(S'g'd) WELLS, SMITH & MACON,
Att'ys for Def'ts.

28 Endorsed: 613. Keyes & Arents *vs.* Grant & Grant. 4th amendment to answer. Filed Jul. 16, 1881. (S'g'd) Edward F. Bishop, clerk.

And afterwards, and on, to wit, the 19th day of July, A. D. 1881, came again the said plaintiffs, by their attorneys aforesaid, and filed in said court and in said cause their replication to the 4th amendment to answer heretofore filed herein; and the said replication is in words and figures as follows, to wit:

Replication to 4th Amended Answer.

In the Circuit Court of the United States, District of Colorado.

WINFIELD SCOTT KEYES and ALBERT ARENTS
vs.
JAMES B. GRANT and JAMES GRANT.

Reply of Plaintiffs to 4th Amendment to Def'ts Answer.

Now come the plaintiffs, by Symes & Foot, their attorneys, and, in reply to the 4th amendment and addition of defendants to their answer, allege—

1. They deny that the alleged improvement of plaintiffs in smelting furnaces was, prior to the date of their patent, published in Karsten's System der Metallurgie, pages 150 to 166, inclusive,
29 and pages 166 to 180, inclusive, in volume 5, and in his Atlas, tab. XLI, figures 850 to 867, inclusive, published in Berlin, Prussia, in the year 1832, or at any time published in said book on any page therein, or in or on any tab. or atlas in connection therewith.

2. They deny that prior to said patent, or at any time, said improvement was published in Watt's Chemical Distionary, vol. 5, on pages 495 & 496, or on any page or pages therein published in London, England, in 1868, or any work whatsoever.

(S'g'd) SYMES & FOOT,
Att'ys for Plaintiffs.

Endorsed: 613. U. S. circuit court. Winfield Scott Keyes *et al. vs.* James B. Grant *et al.* Reply of plaintiffs to 4th amendment to ans. Symes & Foot, for pl'ffs. Filed July 19, 1881. (S'g'd) Edward F. Bishop, clerk.

And afterwards, and on, to wit, the 19th day of July, A. D. 1881, the same being one of the regular juridical days of the May term, A. D. 1881, of said court, present, the honorable Moses Hallett, district judge, the following further proceeding was had and entered of record in said court and in said cause, to wit:

Order. Defendants Granted Leave to File New Interrogatories to Richter et al. For Damages.

30 WINFIELD SCOTT KEYES *et al. vs.* JAMES B. GRANT *et al.*

At this day come the said plaintiffs, by R. E. Foot, Esq., their attorney, and the said defendants, by Thomas Macon, Esq., their attorney, also come. And the objections of the said plaintiffs to the said defendants' interrogatories to Richter, Bannerman, and Percy having heretofore come on to be heard, and the court being now sufficiently advised in the premises, it is ordered by the court, on motion of the said defendants, that they be allowed to file herein and substitute other interrogatories to said parties as they shall be advised.

And afterwards, and on, to wit, the 21st day of July, A. D. 1881, the same being one of the regular juridical days of the May term, A. D. 1881, of said court, present, the honorable Moses Hallet, district judge, the following further proceeding was had and entered of record in said court and in said cause, to wit:

Order. Plaintiffs to File Cross-interrogatories to Richter in Five Days. For Damages.

WINFIELD SCOTT KEYES and ALBERT ARENTS
vs.
JAMES B. GRANT and JAMES GRANT.

At this day come the said plaintiffs, by R. E. Foot, Esq., their attorney, and the said defendants, by E. T. Wells, Esq., their attorney, also come. And thereupon, on motion of the said plaintiffs,
31 it is ordered that the said plaintiffs have until five (5) days from this day within which time to file herein their cross-interrogatories to the interrogatories of the said plaintiffs to witnesses Richter, Banerman, and Percy.

And afterwards, and on, to wit, the 12th day of October, A. D. 1881' the same being one of the regular juridical days of the October term' A. D. 1881, of said court, present, the Honorable Moses Hallet, district judge, the following further proceeding was had and entered of record in said court and in said cause, to wit:

Order. Defendants granted leave to Amend Answer. For Damages.

WINFIELD SCOTT KEYES *et al. vs.* JAMES B. GRANT *et al.*

This day comes the said defendant, James Grant, appearing for himself and his codefendant, and moves the court for leave to amend the answer of the defendants, as stated in the affidavits filed on this day in support of the said motion; and the said plaintiffs, by R. E. Foot, their attorney, also come, and, after argument of counsel, it is considered by the court that the said defendants have leave to amend their answer forthwith, as stated in the affidavits aforesaid, but upon this condition that if, by reason of such amendment, said plaintiffs shall not be able to go to trial at this term, then and in that case the defendants shall pay the costs of this term; and if testimony in addition to that already taken shall be required of and concern-
32 ing the matters alleged in the said amendments, the defendants shall pay the costs of such testimony.

And afterwards, and on, to wit, the 12th day of October, A. D. 1881, came again the said defendants, by their attorneys aforesaid, and filed in said court and in said cause their amended answer to the complaint heretofore filed herein, and the said amended answer is in words and figures as follows, to wit:

Amended Answer.

THE UNITED STATES, } ss:
District of Colorado, }

In the Circuit Court of the United States for said District.

WINFIELD S. KEYES, ALBERT ARENTS, }
vs. } 613.
JAMES GRANT, JAMES B. GRANT. }

And the said defendants, by way of amendment to their said answer herein, say, on information & belief, that the plaintiffs' pretended invention in the complaint alleged had been described in the following-mentioned printed publications prior to the plaintiffs' supposed invention or discovery thereof, to wit:

1. In a certain book entitled "The Mettalurgy of Lead," by John Percy, published in London, in 1870, at pages 418, 419, 420, of said book.

33 2. In a certain printed publication entitled "System der Mettallurgie," von Dr. J. B. Karsten (published at Berlin, Prussia, in 1831–2, in 5 volumes, with an atlas of plates, I, at pages 315, 316, 317, 318, 319, 320, 321, and 322, of volume III, and pages 150 to 166, both inclusive, and 166 to 180, both inclusive, of volume V, and figures 479, 480, 481, 482, 483, 484, 473, 474, 475 on plate XXI, and figures 850 to 868, both inclusive, of plate XLI of the atlas accompanying said work.)

3. In a certain printed publication entitled Handbuch der All-emeinen Hutten Kunde von W. H. Lampadius (published at Göttengen, 1804–10, in 4 volumes), at pages 57, 58, 59, 60, 61, 62, 297, 298, of vol. II, part II, and upon plate VI of the same volume.

4. In a certain printed publication entitled "Elemente der technische Chemice," von Ernst Ludwig Schubarth (published at Berlin, 1835, in 3 volumes, with an atlas of plates), at page- 181, 182, 183 of vol. 1, 2d division, and in figures 13, 14, 15, 16, 19, 20 of plates XI of said atlas.

5. In a printed publication entitled Der Oberharzen Hutten pro cesse, by Bruno Kerl (published at Clausthal, in Germany, in 1863), at pages 290, 291, 307, 308, 309, 310 and figures 53, 54, 55, 56 upon plate III accompanying the same; also at the same places in an edition of said work published in 1860 at Clausthal, Germany.

6. Also the printed publication entitled "A Dictionary of Chemistry," by Henry Watts, published in London, England, 1868, 1869, at pages 489, 490, 491, and following.

(Signed) JAMES GRANT.
WELLS, SMITH, & MACON,
Def'ts' Attorney.

34 IN THE UNITED STATES OF AMERICA, } ss:
District of Colorado, }

James Grant, being first duly sworn, saith, on oath: That he is one of the defendants in the above-entitled suit; that he hath read

the foregoing amendment to the answer of the defendants herein and knows the contents thereof, and the same is true of his own knowledge, except as to matters that are therein stated on information & belief of the defendants, and as to those matters he believes it to be true.

———— ————.

Subscribed and sworn to before me, this 12th day of October, A. D. 1881.

———— ————.

Endorsed: U. S. C. C. No. 613. Winfield S. Keyes *et al. vs.* James B. Grant *et al.* Amended answer (filed by leave of court). Filed Oct. 12, 1881. (S'g'd) Edward F. Bishop, clerk. James Grant. Wells, Smith & Macon, for def'ts.

And afterwards, and on, to wit, the 13th day of October, A. D. 1881, the same being one of the regular juridical days of the October term, A. D. 1881, of said court, present, the honorable George W. McCrary, circuit judge, and the honorable Moses Hallett, district judge, the following further proceeding was had and entered of record in said court and in said cause, to wit:

35 *Order. Cause Continued. For Damages.*

WINFIELD SCOTT KEYES and ALBERT ARENTS
vs.
JAMES B. GRANT and JAMES GRANT.

At this day, on motion of the said defendants, it is ordered that this cause stand continued until the next term, and that the said plaintiffs recover their costs at this term heretofore expended. Let each party give notice to all witnesses on their behalf subpœn-ed herein of this continuance.

Ordered that the defendants' amendment to their answer filed herein hereupon yesterday be allowed to stand, but on condition that if the re-examination of any witnesses heretofore examined on the part of the plaintiff- be made necessary thereby the defendants shall pay the costs of such re-examination.

And afterwards, and on, to wit, the 6th day of May, A. D. 1882, the same being one of the regular juridical days of the May term, A. D. 1882, of said court, present the honorable Moses Hallett, district judge, the following further proceeding was had and entered of record in said court and in said cause, to wit:

Order. Motion to Strike Out Part of Deposition of Percy et al. Granted. For Damages.

WINFIELD SCOTT KEYES *et al. vs.* JAMES G. GRANT *et al.*

36 At this day come the said plaintiffs by R. E. Foot, Esq., their attorney, and the said defendants by E. L. Smith, Esq., their attorney, also come. And the motion of the said plaintiffs to

strike out answers to certain interrogatories to Dr. John Percy and Hillery Banerman, having heretofore come on to be heard, and having been argued by counsel, and taken under advisement by the court, and the court being now sufficiently advised in the premises, it is ordered by the court for good and sufficient reasons to the court appearing that the said motion be granted.

And afterwards, and on, to wit, the 10th day of May, A. D. 1882, came again the said plaintiffs, by their attorneys aforesaid, and filed in said court and in said cause their reply to 5th amended answer of defendants heretofore filed herein; and the said reply is in the words and figures as follows, to wit:

Reply to 5th Amended Answer.

The United States District of Colorado. In the Circuit Court United States.

WINFIELD S. KEYES [and] ALBERT ARENTS
vs.
JAMES GRANT and JAMES R. GRANT.

Now come the plaintiffs by Symes & Foot, their attorneys, and in reply to the 5th amended answer of the defendants filed herein allege:

1. They deny that the improvement or invention of the plaintiffs was described in the following publications prior to the date of their
37 patent or at any time whatsoever, to wit: In the book entitled the Mattal-urgy of Lead by John Percy, published in London, in 1870, at pages 418, 419, 420; in a book entitled System der Mettal-urgie von Dr. J. B. Karsten, published at Berlin, Prussia, in 1831–'2, in 5 volumes, with an atlas of plates at pages 315, 316, 317, 318, 319, 320, 321, and 322; of vol. 3, and pages 150 to 166, both inclusive, and 166 to 180, both inclusive; of volume V, and figures 479, 480, 481, 482, 483, 484, 473, 474, 475 on plate XXI, and figures 850 to 866, both inclusive, of plate XLI of the atlas accompan-ing said work.

3. In a certain printed publication entitled Handbuch der All-emeinen Hutten Kunde, von W. H. Lampadius, published at Göttingen, 1804–'10, in 4 volumes, I, at pages 57, 58, 59, 60, 61, 62, 297, 298, of vol. II, part II; and upon plate VI of the same volume.

4. In a certain printed publication entitled Elemente des teschnische Chemice, von Ernst Ludwig Schubath, published at Berlin, 1835, in 3 volumes, with an atlas of plates, I, at pages 181, 182, 183, of vol. I, 2d division, and in figures 13, 14, 15, 16, 19, 20, of plates VI of said atlas.

5. In a printed publication entitled Des Oberharzen Hutten processe, by Bruno Kerl, published at Clausthal, in Germany, in 1863, at pages 290, 291, 307, 308, 309, 310, and figures 53, 54, 55, 56, upon plate III, accompanying the same, at the same places, in an edition of said work published in 1860 at Clausthal, Germany.

6. In a printed publication entitled "A Dictionary of Chemistry,"

by Henry Watts, published in London, England, 1868, 1859, at pages 489, 490, 491, and following.

And for a more full and complete reply to said 5th amended answer deny that the invention and discovery of the plaintiffs covered
38 by the patent in this case was, at any time prior to the date thereof, published or printed in any of the works, books, or printed matters mentioned in the said 5th amended answer of the defendants on any of the pages and plates mentioned, or on any page or plate therein mentioned.

(S'g'd) SYMES & FOOT,
Att'ys for Plaintiffs.

Endorsed: U. S. C. C. No. 613. Winfield S. Keyes *et al. vs.* James B. Grant *et al.* Reply of plaintiffs to 5th amended answer of defendants. Filed May 10, 1882. (S'g'd) Edward F. Bishop, clerk. Symes & Foot, att'ys for pl'ffs.

And afterwards, and on, to wit, the 29th day of May, A. D. 1882, the same being one of regular juridical days of the May term, A. D. 1882, of said court, present, the Honorable Moses Hallett, district judge, the following further proceeding was had and entered of record in said court and in said cause, to wit:

Order. Jury Come. For Damages.

WINFIELD SCOTT KEYES and ALBERT ARENTS
vs.
JAMES B. GRANT and JAMES GRANT.

At this day come the said plaintiffs, by G. G. Symes, Esq., their attorneys; and the said defendants by Thomas Macon, Esq., their attorney, also come. And thereupon comes a jury, to wit:

George W. Collins, William Nicholson, George A. Gano,
39 Flavius N. Davis, Elbert Beasly, George A. Dexter, William C. Stover, Nathaniel S. Henderson, John C. Carson, Robert Gammon, James M. Cole, G. H. Morse, twelve good and lawful men, and they are duly selected and tried, impaneled and sworn, to well and truly try the issues herein joined, and a true verdict render according to the evidence. And thereupon comes the evidence, the hearing of which is continued to the hour of adjournment.

And the said jurors being each duly cautioned by the court not to converse among themselves, nor with others touching this cause, or the matters at issue herein, or the evidence heard, or any part thereof, nor to listen to such conversation of others, nor to read or hear read any publication touching the same, are permitted to separate to meet the court at its next incoming.

And afterwards, and on, to wit, the 31st day of May, A. D. 1882, the same being one of the regular juridical days of the May term, A. D. 1882, of said court, present, the Hon. Moses Hallett, district judge, the following further proceeding was had and entered of record in said court and in said cause, to wit:

Order. Trial Continued. For Damages.

WINFIELD SCOTT KEYES *et al. vs.* JAMES B. GRANT *et al.*

At this day come again the said parties, by their attorneys,
40 respectively, and the said jurors being now all here present and in the jury box, the hearing of the evidence herein is resumed and continued to the hour of adjournment, when the further hearing herein is postponed until to-morrow, Thursday, the 1st day of June, at the hour of 9 o'clock a. m.

And the said jurors being each duly cautioned by the court not to converse among themselves, nor with others, touching this cause, or the matters at issue herein, or the evidence heard or any part thereof, nor to listen to such conversation of others, nor to read, or hear read, any publication touching the same, are permitted to separate to meet the court as aforesaid.

And afterwards, and on, to wit, the 1st day of June, A. D. 1882, the same being one of the regular juridical days of the May term, A. D. 1882, of said court, present, the Honorable Moses Hallett, district judge, the following further proceeding was had and entered of record in said court and in said cause, to wit:

Order. Trial Continued. For Damages.

WINFIELD SCOTT KEYES *et al. vs.* JAMES B. GRANT *et al.*

At this day come again the said parties, by their attorneys, respectively, and the said jurors being now all here present and in the jury box, the hearing of the evidence herein is resumed and continued to the hour of adjournment, when the further hearing herein is postponed until to-morrow, Friday, the 2d instant, at the hour of 9 o'clock a. m.

41 And the said jurors being each duly cautioned by the court not to converse among themselves, nor with others, touching this cause, or the matters at issue herein, or the evidence heard, or any part thereof, nor to listen to such conversation of others, nor to read or hear read any publication touching the same, are permitted to separate to meet the court as aforesaid.

And afterwards, and on, to wit, the 2d day of June, A. D. 1882, the same being one of the regular juridical days of the May term, A. D. 1882, of said court, present, the honorable Moses Hallett, district judge, the following further proceeding was had and entered of record in said court and in said cause, to wit:

Order. Trial Continued. For Damages.

WINFIELD SCOTT KEYES *et al. vs.* JAMES B. GRANT *et al.*

At this day come again the said parties by their attorneys, respectively, and the said jurors being now all here present and in the jury box, the trial herein is resumed. And the said jurors having heard

the evidence produced herein, as well by the said plaintiffs as by the said defendants, and the instructions of the court, retire to their room to consider of their verdict.

And thereupon it is ordered that should the said jurors agree upon a verdict during the adjournment of the court, they may reduce it to writing, seal it, and deliver it to their foreman to be by him delivered to the court at its next incoming, and there-
42 upon may separate to meet the court at its next incoming.

And afterwards, and on, to wit, the 5th day of June, A. D. 1882, the same being one of the regular juridical days of the May term, A. D. 1882, of said court, present, the honorable Moses Hallett, district judge, the following further proceeding was had and entered of record in said court and in said cause, to wit:

Order. Mistrial. Jury Dicharged. For Damages.

WINFIELD SCOTT KEYES *et al. vs.* JAMES B. GRANT *et al.*

At this day come again the said plaintiffs by G. G. Symes, Esq., their attorney, and the said defendants by Thomas Macon, Esq., their attorney, also come.

And thereupon comes the jury. And it now appearing to the court that the said jurors have not agreed upon a verdict herein, and that if longer detained they would not so agree, therefore it is ordered that they be discharged from rendering a verdict herein.

And afterwards, and on, to wit, the 15th day of November, A. D. 1882, the same being one of the regular juridical days of the October term, A. D. 1882, of said court, present, the honorable Moses Hallett, district judge, the following proceeding was had and entered of record in said court and in said cause, to wit:

Order. 2d Trial Commenced. For Damages.

43 WINFIELD SCOTT KEYES *et al. vs.* JAMES B. GRANT *et al.*

At this day come the said plaintiffs, by G. G. Symes, Esq., their attorney, and the said defendants, by Thomas Macon, Esq., their attorney, also come. And thereupon comes a jury, to wit, Benjamin Despain, James Beattie, Eugene Morganthal, Melvin Edwards, George H. Estabrook, H. C. Sherman, A. J. Moffat, John P. Bartel, Henry Plummer, Robert S. Edwards, John C. Edgar, H. B. Grose, twelve good and lawful men, and they are duly selected and tried, impaneled and sworn, to well and truly try the issues herein joined and a true verdict render according to the evidence.

And thereupon further hearing is postponed until to morrow, Thursday, the 16th instant. And the said jurors being each duly cautioned by the court not to converse among themselves or with others touching this cause, or the matters at issue herein or the evidence heard, or any part thereof, nor to listen to such conversation of others, are permitted to separate to meet the court at its next incoming.

And afterwards, and on, to wit, the 16th day of November, A. D. 1882, the same being one of the regular juridical days of the October term, A. D. 1882, of said court, present, the Honorable Moses Hallett, district judge, the following further proceeding was had and entered of record in said court and in said cause, to wit:

Order. 2d Trial Continued. For Damages.

44 WINFIELD SCOTT KEYES *et al. vs.* JAMES B. GRANT *et al.*

At this day come again the said parties, by their attorneys, respectively, and the said jurors being now all here present and in the jury box, the hearing of the evidence herein is resumed and continued to the hour of adjournment, when the further hearing herein is postponed until to-morrow, Friday, the 17th instant, at the hour of 9 o'clock a. m.

And the said jurors being each duly cautioned by the court not to converse among themselves, or with others, touching this cause, or the matters at issue herein or the evidence heard, or any part thereof, nor to listen to such conversation of others, are permitted to separate to meet the court as aforesaid.

And afterwards, and on, to wit, the 17th day of November, A. D. 1882, the same being one of the regular juridical days of the October term, A. D. 1882, of said court, present, the Honorable Moses Hallett, district judge, the following further proceeding was had and entered of record in said court and in said cause, to wit:

Order. 2d Trial Continued. For Damages.

WINFIELD SCOTT KEYES *et al. vs.* JAMES B. GRANT *et al.*

At this day come again the said parties, by their attorneys, respectively, and the said jurors being now all here present
45 and in the jury box, the hearing of the evidence herein is resumed and continued to the hour of adjournment, when the further hearing herein is postponed until to-morrow, Saturday, the 18th instant, at the hour of 9 o'clock a. m.

And the said jurors being now each duly cautioned by the court not to converse among themselves, or with others, touching this cause, or the matters at issue herein, or the evidence heard or any part thereof, nor listen to such conversation of others, are permitted to separate to meet the court as aforesaid.

And afterwards, and on, to wit, the 18th day of November, A. D. 1882, the same being one of the regular juridical days of the October term, A. D. 1882, of said court, present, the honorable Moses Hallett, district judge, the following further proceeding was had and entered of record in said court, and in said cause, to wit:

Order. 2d Trial Continued. For Damages.

WINFIELD SCOTT KEYES *et al. vs.* JAMES B. GRANT *et al.*

At this day come again the said parties by their attorneys, respec-

tively, and the said jurors being now all here present and in the jury box, the hearing of the evidence herein is resumed and continued to the hour of adjournment, when the further hearing herein is postponed until Monday next, the 20th instant, at the hour of 9 o'clock a. m.

And the said jurors being now each duly cautioned by the court not to converse among themselves, or with others, touching
46 this cause, or the matters at issue herein, or the evidence heard or any part thereof, nor to listen to such conversation of others, are permitted to separate to meet the court as aforesaid.

And afterwards, and on, to wit, the 20th day of November, A. D. 1882, the same being one of the regular juridical days of the October term, A. D. 1882, of said court, present, the Honorable Moses Hallett, district judge, the following further proceeding was had and entered of record in said court and in said cause, to wit:

Order. 2d Trial. Verdict for Defendants. For Damages.

WINFIELD SCOTT KEYES *et al. vs.* JAMES B. GRANT *et al.*

At this day come again the said parties, by their attorneys, respectively, and the said jurors being now all here present, the trial herein is resumed.

And the said jurors having heard the evidence produced herein, and the instructions of the court, upon their oaths do say they find for the defendants.

And afterwards, and on, to wit, the 7th day of December, A. D. 1882, the same being one of the regular juridical days of the October term, A. D. 1882, of said court, present, the Honorable Moses Hallett, district judge, the following proceeding was had and entered of record in said court and in said cause, to wit:

47 *Order. Judgment Entered on Verdict. For Damages.*

WINFIELD SCOTT KEYES and ALBERT ARENTS
vs.
JAMES B. GRANT and JAMES GRANT.

At this day come the said defendants, by Thomas Macon, Esq., their attorney, and thereupon the said defendants move the court for judgment herein.

Wherefore it is considered by the court that the said defendants go hence hereof without day, and have and recover of and from the said plaintiffs their costs by them in this behalf laid out and expended to be taxed, and have execution therefor.

And afterwards, and on the same day, to wit, the 7th day of December, A. D. 1882, the following further proceeding was and entered of record in said court and in said cause, to wit:

Order. Plaintiffs to File Bill of Exceptions in 60 Days. Bond, $500.00. For Damages.

WINFIELD SCOTT KEYES *et al. vs.* JAMES B. GRANT *et al.*

At this day come the said plaintiffs, by R. E. Foot, Esq., their attorney, and on their motion it is ordered by the court that the said plaintiffs have leave to file herein their bill of the exceptions reserved by them upon the trial of the issues herein joined within sixty (60) days from this day.

48 And bond upon writ of error herein shall be in the sum of five hundred dollars ($500.00).

49 And afterwards, and on, to wit, the 7th day of February, A. D. 1883, came again the said plaintiffs, by their attorneys aforesaid, and filed in said court and in said cause their bill of the exceptions reserved by them upon the trial of the issues in this cause, and the said bill of exceptions is in words and figures as follows, to wit:

Bill of Exceptions.

UNITED STATES OF AMERICA, *District of Colorado:*

In the Circuit Court of the United States for the District of Colorado, in the Eighth Judicial Circuit, at the General Term thereof, begun and holden in the City of Denver, in said District, on the first Tuesday of October, A. D. 1882.

Present: Hon. Moses Hallett, district judge, presiding.

WINFIELD SCOTT KEYES and ALBERT ARENTS
against
JAMES B. GRANT and JAMES GRANT.

Be it remembered that on the trial of this cause during the
50 general term of this court, to wit, on the 15th day of November, A. D. 1882, a jury having been impanneled and sworn, the plaintiffs, to maintain the issues on their part, gave in evidence as follows, that is to say:

Plaintiffs, by their counsel, offered in evidence a patent from the United States to the plaintiffs dated the 28th of November, 1871, which was admitted in proof, marked "Exhibit A," and is in the words and figures following, to wit:

No. 121385.

The United States of America to all to whom these presents shall come:

Whereas Winfield S. Keys and Albert Arents, of Eureka, Nevada, have presented to the Commissioner of Patents a petition praying for the grant of letters patent for an alleged new and useful improvement in *in* furnaces for smelting lead and other ores, a description of which invention is contained in the specification, of which a copy is hereunto annexed and made part hereof, and have complied with

it rises to the same level in the tube until it reaches the basin, from whence it may be removed as clean metal.

To enable others skilled in the art to make and use our invention we will proceed more particularly to describe the same.

The figure represents a sectional elevation of a portion of a smelting furnace with our improvements.

A, represents the furnace, which may be of ordinary or common construction. B is a basin of suitable dimensions, located at the top of an extension built on one side of the furnace and at a suitable elevation above the bottom of the furnace. The basin may be constructed of any material suitable for receiving and holding the molten metal. Extending from the bottom of the basin B, to the bottom of the furnace A, through the above-mentioned extension, is a tube, C, which connects the basin with the furnace, and which may be made of iron, clay, or other material suitable for the purpose.

The metal as it melts, falls to the bottom of the furnace as *as* the surface of the molten metal rises within the furnace; it rises to the same level in the tube, C, until it reaches the basin B, from which it may be removed with a ladle.

The advantages of this invention are obvious, as by this
55 means the metal is tapped or withdrawn from the furnace free from impurities, and it will also be seen that the difficulties arising from the formation of hard matter or incrustations on the bottom of sides of the furnace, occasioned by the usual method of drawing off a large quantity of molten metal at one time, are obviated.

Having thus described our invention what we claim as new, and desire to secure by letters patent of the United States, is—

The method of tapping or withdrawing molten lead or other metals from a smelting furnace by means of the basin B and tube or connection, C, in combination with the furnance substantially as shown and described.

WINFIELD SCOTT KEYS.
ALBERT ARENTS.

Witnesses:
L. FETMER.
J. VITTELSHACK. (85)

The plaintiffs then called ALBERT ARENTS as a witness in their behalf, who, being duly sworn, testified as follows:

That he was one of the plaintiffs in this suit; that he is -killed in the science of metallurgy and the art of smelting; that he and Winfield Scott Keys, coplaintiff herein, are the partentees mentioned in said patent; that witness was educated at the school of mines
56 at Clausthal, in Germany, and the University of Berlingen, Germany; had practiced his business and profession something like four or five years in his native home after he had finished his studies, and had practiced his profession in the United States; that is to say, in California, Nevada, Colorado, and Utah; that he had made a specialty of smelting of ores; that he had had charge of

The prevention of accident by fire, lessening the danger to life and health in those cases wherein unskilful tapping, the fused products of the furnace with their injurious fumes escaped the control of the workman and ran over the floor of the furnace;

The doing away with the old mode of tapping, a great saving in economy of time and labor;

The automatic obtaining of clean metal.

That the invention of the plaintiffs was, and has been since its discovery, in use on a large proportion of lead and silver smelting furnaces in the United States.

That many thousands of dollars have been paid to and collected by the patentees in lisence fees for the use of their improvement in different parts of the United States since the issuing of their patent.

60 That the license fee fixed by the patentees for the use of their improvement and invention was two hundred and fifty dollars per year for each furnace in advance, and one thousand dollars when sale was made, for use during the life of the patent.

That the patentees claimed by their patent the discovery of a new and useful result, to wit, the obtaining of clean metal automatically from a smelting furnace of ordinary construction, and the means described by them is a basin placed at a suitable height above the bottom of and on the side of the furnace, connected by a tube made of iron, clay, or other suitable material, from the bottom of the basin with the bottom of the furnace, being the combination of basin, tube, and furnace of ordinary construction, and that the principal upon which the clean metal rises to the basin is the principle of communicating vessels.

The plaintiffs then called in their behalf FRANZ FAHR, who, being duly sworn, testified: That his vocation is mining and smelting; that he was educated at the school of mines in Freiberg, in Germany; that he had been engaged in the practice of his profession for twenty years; that he is now in charge of the large Harrison Reduction Works at Leadville.

O. H. HAHN, who, being duly sworn, testified: That he is
61 a metallurgist; that he was educated at Clausthal, in Germany; that he has been engaged in the practice of his profession since 1864, principally in the Western States and Territories of the United States; that he is at the present time in charge of the Arkansas Valley Smelting Works in Leadville.

ANTON EILERS, who, being duly sworn, testified: That his vocation is a mining engineer and metallurgist; that he was educated at the school of Clausthal, university of Göttingen; that he has been actively engaged in the practice of his profession in this country for twenty years; that he has built and had charge of large *of large* smelting works and furnaces in Utah, and in others of the Western States.

WILLIAM WEST, who, being duly sworn, testified: That he is a chemist and metallurgist; that he first acquired his knowledge of

his own vocation at the Swansea smelting works, in Lancashire, England; that he had been almost continually engaged in the practice of his profession in this country for eighteen years.

WINFIELD SCOTT KEYS, who, being duly sworn, testified: That he is, by profession, a mining engineer and metallurgist; that he was educated at the school of mines in Freiberg, Saxony, Germany; that he has been engaged practically in working at his profession in this country over twenty years; was general manager of the
62 Eureka mines in Nevada at the time he made this invention and improvement, with his coplaintiff, Mr. Arents; that he has since that time built or superintended the building of many different smelting furnaces.

GEORGE W. SMALL, who, being duly sworn, testified: That his vocation is that of mining engineer and metallurgist; that he was educated in Clausthal, Germany; that he had practiced his profession since the spring 1879; that he had had charge of building and operating smelting furnaces.

A. HARDWICK, who, being duly sworn, testified: His business and profession is that of mining engineer and metallurgist; that he was educated and practiced his vocation in Freiberg, Saxony, from 1860 to 1865; that he had been engaged in the practice of his profession in this country since 1866; that he had had charge of different smelting works in Utah and Nevada.

Professor MILTON MOSS, who, being duly sworn, testified: That he is at present professor of minerology and metallurgy at the golden Colorado shool of mines; that he was educated at the school of mines in Clausthal, Hartz, in Germany; that he understands, and in his duties as professor teaches the art of building and constructing furnaces.

63 Each of whom testified substantially to the foregoing facts, to wit: That said method of withdrawing clean metal was a great improvement; that the result obtained by the means described was novel and useful; that said specifications were sufficient to enable a person skilled in said art to produce and obtain the result aforesaid by the means described; and that the parts of a smelting furnace of ordinary construction, at the date of plaintiffs' patent, were, in their application to the arts of smelting, important, and substantially as above stated.

64 The plaintiffs then read in their behalf the depositions of the following witnesses:

ROBERT BIEWEND, who deposed that he is a professor of metallurgy; that he is well acquainted with the literature of his profession; that he is acquainted with the Arents lead-well, and describes the same in his lectures.

JAMES R. COOPER, copper smelter, who has been engaged in his present occupation thirty years.

AUGUST RAHT, of Salt Lake city, Utah Territory, metallurgist, was educated in the mining school of Clausthal, Germany, during the year about 1863; that ever since the year 1864 he has been nearly constantly employed as a metallurgist at different copper, lead, and silver smelting works in Germany as well as in the United States, and in the United States since 1865, and that he considered himself well experienced in the science of smelting.

GUIDO KÜSTEL, of Alameda, county of Alameda, and State of California, mining engineer and metallurgist, was educated at the mining academy of Freiburg, in Germany, during the years 1837, 1838, and 1839. During this time Mr. W. A. Lampadius was teacher and professor of metallurgy in said academy; that
65 he had been engaged in metallurgical pursuits ever since the year 1840, and had knowledge and experience in the smelting of silver, lead, copper, and iron; that he was the author of the three following treatises on metallurgy: Treatise on gold and silver processes of California and Nevada, 1863. (2.) Treaties on the concentration of all kinds of ores and chlorination of gold ores, 1868. (3.) Treatise on the roasting of gold and silver ores—1st edition, 1870; 2d edition, 1880.

C. A. STETEFELDT, of New York city, mining engineer, educated at the school of mines, Clausthal, Germany, deposes that he had been practically engaged in metallurgical pursuits since he left Clausthal; that he has knowledge and experience in the reduction of silver, lead, and copper ores.

MAX MOELLER, of Eureka, Nevada, metallurgist and assayer, deposed that he studied metallurgy during 1860, 1861, 1862, and 1863 at the mining academy of Clausthal, and the universities of Berlin and Gottengen; that he had been engaged in metallurgical pursuits since 1865; and had during that time acquired knowledge, skill, and experience in the art and science of smelting and reducing silver, lead, copper, and iron.

CHARLES CONRAD RUGER, of the city and county of San Francisco, California, deposed that he is a mining engineer and metal-
66 lurgist; that he studied metallurgy from 1863 to 1865 in San Francisco; in 1865 in Washoe, Nevada, also in Grass Valley and Nevada City, California, in 1865 to 1867; in Freiberg, Saxony, in 1867, 1868; in the Harz Hanover in 1868, and on a seven months' tour through the most important mining schools of Freiberg, Clausthal, and Berlin; that he had been engaged in metallurgical pursuits since the spring of 1863, and had knowledge, skill, and experience in the smelting of silver, lead, copper, and iron.

S. B. CHRISTY, instructor of mining and metallurgy at the university of California, residing at Berkely, Alameda county, State of California, deposed that he had entire charge of the instruction in the departments of mining and metallurgy at said university, and the direction of the metallurgical laboratory; that he had been interested in and had more or less to do with furnaces for the last

twelve or fourteen years, and had worked at some of them; that for the last eight years he had made a special professional study of furnaces used for smelting copper, lead, quicksilver, iron, and so forth; that he had studied all the leading standard works on the subject in the English, German, and French languages, and had used every opportunity for the personal inspection and study of furnaces in actual operation.

67 Each of whom testified substantially to the foregoing facts, to wit, that said method of withdrawing clean metal was a great improvement, and that the result obtained by the means described was novel and useful.

The plaintiffs then called in their behalf JAMES B. GRANT, who, being duly sworn, testified that the defendants were copartners in the years 1878 and 1879, and that the defendants operated and used furnaces with the improvement of the plaintiffs', as follows: Two furnaces in the year 1878, and eight furnaces in the year 1879.

The plaintiffs then rested their case.

68 The defendants, to prove the issues on their part, first, called JAMES B. GRANT, who, being duly sworn, testified as follows, to wit:

I reside in Denver; my business and occupation is smelting.

Q. How long have you been engaged in Smelting?

A. Nearly four years.

Q. What education have you had, if any, in metallurgy, and where did you acquire that education?

A. I studied at Freiberg, first, the most I learned about it, and then Colorado the most I learned practically.

Q. How long did you study in Saxony?

A. Two years.

Q. When did you leave that country?

A. I- 1876; after I left Saxony I came to Colorado.

Q. Have you been here ever since?

A. Yes, sir.

Q. When did you commence actual and practical smelting?

A. In 1878, September.

Q. Do you think you acquired a thorough education in metallurgy?

A. Well, sir, it is not thorough; it is as much as people generally get at college.

Q. You mean you didn't study so many books?

A. I Studied as many as the ordinary students, I suppose; I didn't know a great deal about the business when I started to work at it practically.

Q. You think you now uuderstand metallurgy theoretically and practically?

A. Yes, sir; I have had charge of the works of the J. B. Grant company and the Grant Smelting Co.

Q. Have you been in charge, continuously, of that smelter since it was built and blown in first?

A. Yes, sir.

Q. How many furnaces have you built in that time?

69 A. I think there have been about 20 to 22.

Q. Have you in the building of these furnaces experienced and difficulty in making them operate?

A. Oh, yes, sir; have had some difficulties.

Q. Have you succeeded in making them all operate properly?

Ans. Yes, sir.

Q. You have already stated here that you have been using what is called the Keys and Arents attachment. Explain to the jury now just how your lead-well and channel are arranged in your furnace?

A. The lead-well on the furnace, the first diagram, the first difference from this; this tap is not half as long, this tap here, in all our furnaces; a furnace about 36 inches across the tuyeres the tap is about 17 or 18 inches long; then, again, three or four times as large in proportion to the furnace, as this. Another difference is, all of our taps, as put in to-day, touch the furnace about 12 inches from the bottom instead of going right to the bottom. The object in putting that tap there is simply this: We find after operating furnaces—we sometimes have careless workman—we could run this slag down into this tap gradually and dip this lead out; after a furnace is operated in that way sometimes careless men on hand are apt to get the slag in this after running the furnace awhile, melt out a portion, make a second hole right on top of it, running the lead over in the tap basin. With those differences—about all—the tap is pro-

70 portionately sever- times as large, being four to six inches square. The basin something similar—a little deeper.

Q. State whether the use of the Keys & Arents attachment prevents the formation of sows or bears.

A. No, sir, it does not.

Q. In your operations have you encountered these animals?

A. Yes, sir.

Q. Do you know that in the other smelters at Leadville, using this Keys & Arents attachment, that they encounter these same difficulties?

A. Yes, sir; they do; plenty of them buried around the furnaces; smelters usually get them out of sight; it is not much credit to them to make them.

Q. Do you know anything about the celebrated Eureka furnace that we have something of from the plaintiffs' witnesses.

A. I have seen most of the furnaces working at Eureka to-day; was there last summer.

Q. Do they use the Keys & Arents attachment?

A. Yes, sir.

Q. State to the jury what their practice is as to cleaning furnaces?

A. They find it necessary there, owing to the large amount of arsenic and iron in the ore; they find large accumulations of this matt- and speiss; they take out the front of the furnace every eight hours, rake of- this accumulation on the lead bath.

Q. It was said here by Mr. Keys that their furnaces, or their attachment, did not prevent the formation of accretions, but that they could not possibly extend below the lead bath in the crucible. State how a sow or an accretion may be formed so as to prevent
71 the working of the furnace without reaching the bottom.

A. Well, it won't go under the lead bath; no less than bringing out the slag in that lead-well can make it stop up that tap; can go to any furnace and dip six or seven thousand pounds of lead without stopping; the tap is above the bottom of the furnace; of course you can't get that lead that is below the bottom of the tap. For instance, the tap would strike the bottom here (diagram). The slag might not be fluid enough to run in the tap; as soon as the slag got there it would stop the flow of the lead into the well; I know that to be a fact from practical experience.

Q. To what cause, usually, is the formation of these accretions due—to the form of the furnace or lead-well, or to to the qualifications of the man who runs the smelter?

A. Those accretions are due almost entirely to the character of the ores that are smelted, and the manner in which they are mixed; if you have too much iron in your ores it is certain to form them, whether you have this lead-well or not. If you have your charge just right, and your furnace does not leak any water, doesn't get too cold, you wont make them in any furnace.

Q. How do you usually judge of the manner in which the furnace is worked; by examining the lead in the lead-well, or how?

A. No; I usually examine it by the slag that the furnace is making. Your lead-well may be in good shape, and your furnace doing very bad work; it is no index whatever of the character of
72 work your furnace is doing—none in the least. These accretions are formed accidentally, and from ignorance and from miscalculations; examining the slag is the index; I never look at the lead-well at all; see the slag removed, can tell by the character of the slag how the furnace is working.

Q. I ask you whether that method of determining how the furnace is working is peculiar to yourself or to the smelters you are acquainted with generally?

A. I don't know that it is; I know our ores carry a certain amount of iron, or some other metal than lead, after working for months; can tell when the slag flows out of the furnace from its fluidity, its clearness, its brightness, its smo-thness?

Q. What I mean by my question is, do other smelters besides yourself judge of the operation of the smelter in this way?

A. Well, I could not answer for them, every man has his own way; judge from the way they run, some of them may judge from the lead-well.

Q. Describe to this jury what a sump furnace means in technical language.

A. I think I can read that better from a book in a very few words—it is very short.

Objected to by plaintiffs, because incompetent, and because no

proper foundation had been laid for the introduction of this book; but the court overruled said objection, and permitted said book to be read in evidence; to which ruling of the court in overruling said objection the plaintiffs, by their counsel, then and there excepted.

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Ans. "A sump furnace is a shaft furnace, in which the hearth is partly on the inside and partly in front of the furnace. The slag runs off of itself from the forehearth. The metal and the matte is tapped out. Sometimes these sump furnaces have no tap basin, and then the metal is dipped with ladles out of the forehearth," that is, out of the basin in front of the furnace. Karsten's Systern Metallurgy, vol. 3, page 318.

Q. The running of the slag in front is not a part of the definition of a sump furnace at all?

A. No, sir; a sump furnace, according to that description, would simply be a furnace with two communicating vessels, one on the inside and one on the out.

Q. State whether the term hearth as used in that book don't mean the crucible?

A. Yes, sir; it means the place to collect lead, usually speaking, in metallurgy, that is what it means.

Q. When you were studying your profession in Germany, what sort of furnaces were they using?

A. They were using furnaces something similar to what we use to-day in Colorado; they were round instead of rectangular, but so far as the bottom was concerned the crucible, and all the other appliances, with the exception of this lead basin, they might be called similar to the furnaces we are using to-day.

Q. They were not using this Keys & Arent's attachment in Germany?

A. No, sir; not at Freiberg, where I studied.

Q. Did you work at any of those furnaces?

A. Yes, sir.

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Q. Were they tapping metal from the bottom of the furnace into an outside basin?

A. They usually had a large basin placed on a railroad track, so it could be removed.

Q. What was the capacity?

A. They smelt there from 25 to 30 tons a day.

Q. How often did they have to open the furnace and drain it out?

A. Well, they rarely ever open a furnace *a furnace* there to clean it out.

Q. How long did you know of any of those furnaces running without being cleaned out?

A. I know of one furnace, there, one I noticed, running twenty-one months; one in bla-t there, I asked the manager of that one how long it had been running; he said over two years, without ever being blown out or repaired.

Q. Did you witness during that time the withdrawing of metal from this furnace?

A. Yes, sir?

Q. What difficulty did the workmen experience in withdrawing the metal, and in stopping it when they desired to?

A. They did not have any difficulty that I saw.

Q. About how long did it take them to make *them to make* a withdrawell of the lead, and stop up the furnace?

Ans. Well, it required a very short time; that depended altogether upon the amount of lead that was in the furnace; I don't think that it ever took them longer than two or three minutes; five minutes, I should say, at the outside.

Q. Did you work around that furnace?

Ans. Yes; I worked there, and helped them tap it; I assisted in doing all kinds of work around one of those furnaces.

75 Q. Did you experience any great difficulty in getting your clay to stick?

A. I didn't use clay at all, simply had a sharp stick, something like this; side of the furnance must have been 18 inches; never saw the inside of it; when the lead was drawn out to the oxygen of the air, drove this in, then broke it; that would char—become like charcoal; heated a bar red-hot and drove it through that charcoal when we tapped more lead. It is a comparatively easy matter to open a furnace and to close it. The slag escaped on the apposite side from the front; there was a spout attached.

Q. Is there anything new in the Keys & Arents' attachment in the withdrawing of the slag from a different side from that from which the metal is withdrawn?

A. No, sir; it has been common with smelters to withdraw the metal from any point of the furnace where they chose to do it. To-day the furnaces are made with iron. There is a hole left in the iron. Ordinarily the smelter can tap his furnace anywhere where provision is made.

Q. We heard a great —— about the rapid destruction of furnaces by the old method of tapping, being required to rebuild them frequently in operating, at least; state to what that was due principally?

A. I think, as Mr. Keys said in the use of this brasque, made furnace bottoms out of that, but since have been making them of brick; before Keys & Arents' patent I think crucibles were built of

76 brick, in 1867 and '68—good firebrick crucibles. They will last just as long by tapping in the old way as they will with this tap.

Q. What is the better preservation of the furnace principally due to?

A. To the manner in which the crucible is built, being built of brick instead of this brasque as formerly, and due to the use of a jacket. The model there will show it—first introduced in 1867; it consists of a hollow wrought-iron jacket. The hottest portion is right opposite the tuyeres. Before they invented these water jackets, and applied them, they never could run a furnace over thirty or sixty days, not on account of the destruction of the crucible so much as the burning out of the brick. In his lectures at Freiberg, Prof. Richter attributes the long life of the furnace almost entirely to the water jacket; in his whole lectures there he hardly spoke of this lead-well as being the cause.

Q. Who discovered this water jacket?

A. I think it was Pillz, a practical smelter there at Freiberg. The water circulates in it all the time, the ore melts and runs out, the slag doesn't get in. They work for years; may break at any time; cast iron.

Q. Did you see Matthews and Geist tap their furnaces?

A. Yes, sir.

Q. Were they tapped in the old method, from the bottom?

A. Yes, sir; I don't know how close to the bottom they were tapped.

Q. You may go on and state about how long it took them to withdraw it?

77 A. I saw them operate their furnace there; didn't tap out very much lead—a ton at a time. They did it very quick; it took less than two minutes to open a furnace and close it at Freiberg. To run out three or four tons at a time it took longer.

Q. That was at Pueblo, was it?

A. Yes, sir.

Q. Working how many furnaces?

A. Six.

Q. How many did they have the Keys & Arents attachments to?

A. I think it was four; I am not sure; either two or four. I think they had the well on most all the furnaces; they were not operating it; it was closed on all but two at the time I speak of.

Q. In the course of your studies and your practice have you become capable of building a furnace from the drawing or model?

A. Yes, sir.

Q. You understand drafting, do you?

A. I can understand a diagram; yes, sir.

Q. Prior to the alleged invention of Keys and Arents was there a publication in any printed book which described a furnace that worked upon the same principle, and substantially in the same way that the Keys & Arents furnace or attachment works?

A. Well, there is a description of a furnace that, so far as the withdrawal of the metal is concerned, worked in the same way; that is, worked on the same principle and could be made to produce the same result.

Q. What book was that?

A. Karsten's System of Metallurgy, volume 3, page 320; volume 5, page 166, gives the dimensions of a furnace that nearly gives the dimensions of a certain furnace.

Q. Could you, from the description that you see in that
78 book, construct that furnace?

A. Taking the descriptions with the drawings, I could construct that furnace and produce that result.

Q. Did you ever construct a furnace after that description and drawings?

Ans. Yes, sir; I constructed a furnace after drawing in No. 860 in Karsten's Atlas, and found the description given in Karsten's, volume 5, page 166.

Q. State how it worked.

(Witness exhibits to the jury a black-colored model.) A. This is a model showing the exterior, the crucible inside; and it here represents the description of that furnace that is in Karsten, volume five, page 166, in the atlas, figures No. 860, I think, page 21. The dimensions on that page say that this furnace is forty-two inches; it does not correspond to our inches Kallenberg's measurement; it might be a little shorter or longer. According to that description it says that this furnace is 42 inches from this tuyere to the front wall. The tuyere is fourteen inches from the top of this lead basin. I am just explaining this model. We get the drawings in that book, and we get the dimensions. I built that furnace at Leadville, and that basin, in accordance with the dimensions given there, and the depth of the lead-well. After finding out that this was fourteen inches from here to the top, took the compasses and measured off from the drawing the depth which this lead-well should be built in that furnace; operated it so at Leadville. When I started it, melted, some lead came down. You charge it just as you do the other fur-

(Here follow diagrams, marked pp. 79, 79½, 79¾.)

80 naces, and, after getting it full of lead, commenced charging the ore, and the furnace went to smelting, and we dipped the lead out of this basin; we drew the slag in different places; had the furnace so built could draw the slag off from the side or where we wanted to; that got just as clean metal as any furnace. I then made a second hole for the slag by the side, run it off in a channel here, similar to that; then drew the lead off right over the lead-well, as the drawing shows, and the slag went over the lead, formed a thin crust on there; we would throw that off, and get the lead out.

Q. Did you get it as clean as you did out of the Keys & Arents attachment?

A. Yes, sir; a little lead would adhere to the slag; we would take that and work it over again.

Q. Put that together (model) if you can, and illustrate how it works. Perhaps you better take this model (witness pours quicksilver in one of the black-colored models).

A. That furnace, built on that model, would effect the automatic separation of molten metal from the slag just as completely as any furnace that was ever built in the world; so long as the metal remains above that closed eye it is impossible for any lighter material to come down in there and get out into this outside basin. The only difference between their old method of operating it and ours was that the Germans drew out it over this lead-well, and then that slag which lay on there; they would dip it out—dip the

81 metal out; after the slag would be chilled they would through it off; whether they ever operated Karsten's furnace I don't know; we do know they described them in their books; they speak of the metal going through the lower hole and the slag going through the upper hole. Having built on this plan, you get it ready to start; the metal will stand in it just as high, if there is no pressure,

on the inside as on the out; when you commence making slag the question arises as to the removal of it.

Q. If no extraneous or foreign pressure is applied to the top of the lead inside of the crucible it will it show itself here, will it?

A. Oh, yes; that will press out if there is any pressure brought to bear. In fact, both in that furnace and the Keys & Arents furnace there is always other pressure than that weight; the slag and the pressure of the blast, and the weight, to some extent, of the charge.

Q. In working that furnace, is there any more danger of slag getting in through this eye than there is through the Keyes & Arents attachment?

A. This well in Karsten is lower in proportion to the other portion of the furnace than the well we have there to-day. In smelting to-day from the top of our lead-well down to the bottom is about thirty inches. Judging from the dimensions given in Karsten, I should not think this over 14 to 16; when we are smelting we have a pressure of three-fourths of an inch. That pressure is right on top of the molten metals through these tuyeres here, pressing the lead down. This lead will flow down probably an inch to an inch
82 and a quarter; it stands higher in the outside basin than in the inside.

Q. Does the fact that the hearth, as described by Karsten, is only about fourteen inches have anything to do with the danger of slag coming in?

A. No, sir; can take a lead-well fourteen inches in practice and work without getting slag in there by careful work.

Q. Since the dimensions of the outer hearth were there given, would the practical smelter have had any difficulty in raising it high enough to avoid that difficulty; was it, or not, a mere matter of mechanical construction to raise it higher?

A. Yes, sir; that was all; mechanical construction.

Q. State whether you have worked a furnace with both the Karsten forehearth and the Keys lead-well?

A. I have worked a furnace with the inclined tap as shown there, and a right-angle tap as shown here.

Q. Does it make any difference in the law of hydr-statics or communicating vessels whether the top is inclined, as in that picture, or straight, as here?

A. It does not make any difference in the principle involved.

Q. Have you had a furnace with each of these attachments, Karstens and Keys attachment, and worked them; if so, state to the jury.

A. Yes, sir; I worked a furnace in that way. I have a model of a large funace I built. It had been working about sixty or ninety days when it was burned down; there are two holes, the one this side cut to the interior of the furnace by an inclined tap, the other in front
83 cut by a right angle. We worked that furnace sixty or ninety days—about two months before the works burned down; operated two wells all the time; one with an inclined tap, the other with a right-angled connection.

Q. When the blast was removed would the lead sink in each one of those two lead-wells exactly alike?

A. Yes, sir.

Q. When the blast was renewed would it rise to the same height?

A. Yes, sir.

Q. Now, when the slag came out through this eye above the lead-well, had you any means of preventing its flowing into this basin if you desired to keep the basin clear of slag?

A. Yes, sir; I did operate it so, and put a piece of sheet-iron there to run the slag across the lead bason.

Q. Did the slag flow continuously or at intervals?

Ans. It flowed sometimes continuously, sometimes at intervals.

Q. You heard somebody say if a furnace were constructed on Karsten's plan, with the slag eye left always open, a man would be in danger of his life; did you discover in the working of this furnace any such dangers?

A. No, sir.

Q. You were running a large furnace?

A. When we run any furnace constantly, run slag constantly, if you have the taphole running out faster than you are making it everything will blow out and make it very disagreeable in running a furnace; you have got to keep experimenting with it until you get the hole just large enough to suit the slag that is being made; this is the model after Keys and Arents; this is a model after that
84 drawing, practically the same as that, with the exception, you see, they have made the inclined tap here; I have added one at right angles, coming down here and rising up to the surface.

Q. You may read, Mr. Grant, from Karsten's work the description of this furnace, how it was used, and what it was used for.

A. The description of that furnace gives the dimensions; this particular description there represents an ideal sump furnace—this furnace; this particular furnace is built from a model in the book.

Q. Just read from the book, and show to the jury.

A. I will just read as I stated before: "The shaft furnace, in which the hearth is partly in the furnace and partly in front of it (page 318). The slag runs of its own accord over the forehearth, and the metal and matte is dipped out into a tap basin. Sometimes, however, these tap basins are dispensed with; that is to say, out of the basin or sump in front of the furnace."

Q. Explain to the jury what is meant by tapping, if from the basin?

A. Having got the metal out here, then you bore a hole in the side or end, and tap that metal off; have a simple lead basin. That is what it means by tapping it off; but he says these furnaces sometimes dispense with these tap basins, if you chose to do it.

On page 320 he say- again, speaking of a sump furnace (479–481): He speaks of that being a sump furnace with a covered eye; and
85 by a covered eye he means, I should judge, the metal standing above the eye on both sides, inside and out, and you cannot see it. He says the slag enters either through that

lower hole into the forehearth or we use a second open eye above the forehearth, the only object of the upper eye being to withdraw the slag. (Of course the inference is, the use of the lower one is to withdraw the metal.) But in smelting operations, where little or no slag is produced, the upper eye is dispensed with, and everything passes through the lower. For litharge, oxide of lead, in using that furnace, they would dispense with the upper eye.

Q. What is the date of that book or publication?

A. 1831.

Q. How, in those days, did they charge smelters; if you know by literature?

A. I should judge the metal was fed into furnaces, just as it is to-day.

Q. Did they make any preparation by putting in first metalic lead?

A. I guess not, as far back as this; there is nothing to show it, anyhow. This partition in front is not permanent. There are two kinds of sump furnaces—those with open breast and those with closed breast. This space in there apart from the partition—a sump furnace with an open breast—has practically only one eye, that extends to the outside. So he describes a sump furnace (page 320): A sump furnace with an open breast, in which the slag has no special opening. That is all it says about it. This top part just touches the metal. Such a furnace as that is operated now.

86 Q. Does he or not say that the material between this slag eye and the metal eye, covered eye, is brasque, which is a mixture of fire-clay and charcoal or coke?

A. He does. It is fire-clay and coke, we make it.

Q. And which is more perishable than brick?

A. Yes, sir; more easily broken up than brick. In those furnaces, all of my first furn*ish*es made in Leadville, the brasque, that partition, was only four inches thick. It stood; worked a furnace nearly a week.

Q. Go on and finish reading the description given by Karsten in his other volume, the 5th volume.

A. Here it is, volume 5. He says: "The form or tuyere is four-te-n inch- above the horizontal surface of this 'front basin.'" Forehearth it is called here. "The height of the shaft furnace from the form to the feed-door is forty-four inches; that is, from here up to where the ore is fed in. This only represents a short portion of the shaft. The inclination of the furnace (going down this way) is the same all round. It has the same breadth on the front and the back, and the depth, from the tuyere to the front of the well, is forty-two inches, Kallenberg's measurement."

It goes on to tell about the coal and coke that is used: "As fuel, we use coke mixed with coal in certain proportions, and that the furnace when running was kept dark at the doors. Instead of the blaze going out at sometimes at the feed-door it was

87 dark, and we use one hundred pounds of ore.

There is a section of that furnace represented by that side view, Table XLI, No. 860.

That section represents this furnace with the model. The model only represents the furnace up to that height. That represents this outside basin. There is the partition; there is the small hole that comes out there where the mercury came through; there is the interior of the furnace. In the description of the furnace he says from the center of this tuyere down to the top of this basin would be fourteen inches. He doesn't give the depth of this well. In making this we don't know whether we make it exact or not; taking the compasses we can get it pretty accurately.

Q. You could get it as accurately as you could from that thing there (plaintiffs' diagram), could you?

A. Yes, sir.

Q. Couldn't you get it a great deal more accurately?

A. Yes.

This one here is a drawing of a furnace that was actually used; the others are mere ideal representations. No. 473 is merely an ideal representation, a drawing sufficient to show what he was trying in reasoning — illustrate.

Q. Is that plate XXI with the numbers referred to in volume three?

A. Yes, sir.

Q. Who made this model, this high one?

88 A. That was made by a mechanic at the Colorado Iron Works.

Q. From what did he make it?

A. I gave him a drawing, a copy of that one, and told him to make it from it; told him to make it inside just as the drawing was; all we wanted was the inside and the outside of the basin to make this and that and that hole just as nearly to correspond with the drawing as he could.

Q. State whether or not it is still an object with smelters who use the Keys and Arents attachment to keep the surface of their lead-well covered—the surface of the lead in the well covered?

A. It is not a general custom. Sometimes when the lead is smoking very hot, much arsenic in the ores, they through on a little lime or charcoal to absorb the lead fumes.

Q. Do you know any smelters in Leadville who do that?

A. I suppose men working around furnaces all do it.

Q. Do you know of Mr. Eilers doing it?

A. I don't know; that is something that might be done by any smelter or man working around the lead-well; if it is smoking very much, and he wants to stop it in some way, through a little lime on it or charcoal.

Q. State whether this Keys & Arents lead-well is any very great saving in labor or time or requires any less skilled labor than the old furnace?

A. No, sir; I honestly believe there is no amount of money saved by using it. I thing that is a convenience for re-

89 moving the lead from the furnace, and it serves no other purpose in the world. I believe I can build two furnaces,

one with the other arrangement, and can make just as much money. This one with the well will afford better facility; it will take just as many men around the furnace; probably take a little more fuel to use this with the tap, because the lead is always exposed to the surface and is gradually cooling.

Q. That requires a little more fuel with the Keys & Arents attachment?

A. That I don't know, but judge so. I know it does not prevent the formation of incrustations; in fact, they are something that now we avoid making by other means. They should not enter into a smelter's calculation, because he ought not to make them. I don't think it is used for any other purpose except to remove the lead.

Q. It is true that latterly furnaces have been built with greater capacity than formerly?

A. Yes, sir.

Q. The small furnaces obtained in the time that Karsten's description of this furnace was written?

A. Yes, sir; everybody used furnaces of any kind in smelting lead; made very small ones.

Q. In building a furnace to use the Karsten lead-well, you would perhaps build it all larger, the lead-well and the inside of the crucible?

A. Yes, sir.

Q. It seems that the Grant Smelting Company, after it went into operation, paid the lisence to Mr. Keys and Arents?

A. Yes, sir; paid it one year.

Q. State for what reason.

90 Objected to, because immaterial and incompetent; but the court overruled said objection; to which ruling of the court in overruling said objection the plaintiffs, by their counsel, then and there excepted.

Ans. Well, for two reasons; one was, we had notice from S-mes & Foot that they would commence suit against us, and, not having time to examine it, and not wishing to get into a law-suit, and believing on their representations they had a valid patent, we paid. Another reason was that Mr. Keys was there and had charge of most of the large mines; we thought it better to be on good terms with him. We had consultation among ourselves, members of the firm, about it.

Cross-examination of JAMES B. GRANT by plaintiffs' counsel:

Governor, the last thing you said was the Grant Smelting Company settled with Messrs. Keys & Arents and paid this license for two reasons: First, because you hadn't time to look it up to see whether it was a good patent; you believed it, because myself and partner wrote you a letter saying it was; and, again, Mr. Keys was in charge of many large mines at Leadville, controling a large output?

A. Yes, sir; some of the mines; I said that had something to do with it.

Q. Will you state when you made this attachment with Arents and paid for the Grant Smelting Company this licence?

91 A. My recollection is, in the spring of 1880.

Q. Was it not September, 1880?

A. I can't tell you the date, Mr. Symes.

Q. Will you say it was not in September, 1880?

A. I know we had it under discussion quite a long time before we did pay it.

Q. If the receipt given—if the New York draft given by you on Colgate & Co., Wall street, was dated September 14th, 1880, will that refresh your recollection so you can state it was about that time?

A. Well, yes; if I had the receipt, could see it; but I would say that we had that matter under consideration quite a long time and a number of times; and our determination to pay that draft may have been several months before it was actually paid. Sometimes all the partners of the firm were there, sometimes they were gone several months; I know we had that matter under discussion among ourselves; we may have come to the determination to pay that draft some time before it was paid.

Q. Before this hadn't Mr. Keys resigned his position as manager of two mines in Leadville and gone to the Pacific coast to his home?

A. I don't know whether he had resigned his position in the iron mine or not; I don't think he had.

Q. You know that he was not manager of the Chrysolite for some time before that?

A. Yes, sir; my recollection is, he left the Chrysolite some time in the summer of 1880; that is my recollection.

Q. Your other reason was, that you hadn't time to investi-

92 gate it.

A. Yes, sir.

Q. You had been educated at Freiberg; you had heard lectures there, you say, mentioning this Keys' & Arents' lead-well?

A. I did not say so.

Q. Did you not say you scarcely ever heard about it?

A. I don't remember that I ever heard it mentioned there, although it might have been; the first year I was there I did not understand German very well; the professor might have been lecturing and I might not have understood; the lead-well was not called to my attention particularly; I never noticed it much until I went to Leadville; my knowledge of it practically dates from that.

Q. It took a long amount of investigation to cipher out this old Karsten furnace and change it so as to make a mongrel lead-well of it, didn't it?

A. No, sir; Professor Percy, one of the most distinguished metallurgists in the world, and the most widely known, wrote a book in 1880; this thing had been called to his attention; he condemned it as being a fraud—no; I don't say that—but it was old; the principles were known before, and cited this Karsten furnace; that book, my recollection is, was published in 1880; any way, it did not come to my attention until in the latter part of the year.

Q. Do you wish to be understood as saying it was a fraud?

A. He said they had no right whatever to patent it; the thing was old, and he cited this furnace.

Q. Is this man Percy any professor?

A. Yes.

93 Q. He said it was nothing but a new combination?

A. What Professor Percy does say is that the principle is the same; that the Karsten furnace can be operated so as to produce the same result. It operates on the same plan; can be made to withdraw clean metal from the furnace; that is about what he says. I don't remember his exact language.

Q. Does Percy say that he ever saw it operate—a practical attempt to put it in operation?

A. No, sir.

Q. Does not he specifically say that he has not?

A. I don't remember that.

Q. Is it not a fact that Professor Percy, an Englishman, in writing upon this, theorizes purely about the lead-well?

A. Yes, sir; so do all your experts. I think, if you will look over the testimony that they gave before, not one of them ever said they saw the Karsten furnace in operation. We claim the Karsten furnace has got a lead-well.

Q. Professor Percy theorizes only?

A. Yes, sir; he theorizes; I am satisfied he never saw it.

Q. Did you see Prof. Percy's deposition?

A. Yes, sir.

Q. You have read it; doesn't he expressly say in his deposition that you took in this case——

The COURT: I don't think the examination at all profitable. The deposition will show for itself what was said; you have a right to use it.

Q. I believe you admit that Percy never saw it?

A. He never saw it.

Q. Therefore, what he wrote about it we call theory?

A. Yes, sir.

Q. You say when you left college you didn't know a great

94 deal about smelting—that is, practically?

A. That is, practically.

Q. That you had difficulties, like all smelters, in erecting and operating your furnaces. As you studied, devoted yourself to it, you progressed and became more perfect all the time?

A. Yes.

Q. You never constructed that so-called Karsten furnace that you say that you constructed a short time ago at Leadville, with the same result, until after you had used practically the Keys & Arents lead-well for nearly two years?

A. Well, I consider it in 1881.

Q. You commenced using the Keys and Arents practically in 1879?

A. I commenced using communicating vessels.

Q. So that then you had *then had* over two years' practical experience in using the lead-well, before you proceed with Karsten's book and figures in his atlas to construct the combination of the Keys and Arents lead-well with Karsten?

A. I don't know as it is any combination. I simply saw this drawing in Karsten, took it and constructed a furnace from it, with the view of producing a certain result, and did produce it.

Q. You didn't construct that furnace, and operate it, producing a certain result, until after this suit was commenced, after you were sued; you constructed and operated that furnace to produce the re-result from your experience in the use of the lead-well for two years, and your studying up of this book of Karsten's after this suit was commenced?

95 A. Yes, sir; and I can tell you what I did it for—simply to prevent your experts from misleading the court and jury in regard to the facts in this case; I never put it up to work for money.

Q. In fact you would loose money if you were to run it of that size?

A. I would have built it larger, of a capacity of thirty tons; just enlarged the whole thing.

Q. Why didn't you, then, to show that the old Karsten forehearth is applicable?

A. I did show that it was applicable.

Q. You think it is the same operation, making just as good a result?

A. I say, if you are going to run only five or six tons, it is impossible to make any money out of it, but, so far as the construction is concerned, it might just as well be built on Karsten's principle as any other.

Q. You admit, if you had run this Karsten mongrel furnace, you would have lost money?

A. No; I don't admit it; that question would have to be determined by months' experience.

Q. How many months w-e you building the furnace?

A. Six weeks or two months from the time it started.

Q. You devoted a good deal of time and ingenuity and ability to it?

A. No great amount of time; simply made drawings, gave the workmen the dimensions, and told them to build it.

Q. Have you got a model of the Karsten furnace that you built and operated at Leadville?

A. Not of that specifically. The interior of it was something similar to that on the insides.

96 Q. This is the one?

A. Yes; that was the drawing from which that was taken, only I made the proportion; I can give the dimensions of the furnace.

Q. Never mind, Mr. Grant, we will have to get along now. You have read from volume five, page 166, of Karsten?

A. Yes, sir.

Q. Read those two or three lines there that are marked on that page, 3 to 6, I believe it is, as you interpret it?

A. Yes, sir; that is 164, not the page that I read from, sir; that describes another furnace entirely from the one I have described.

Q. Read what you read before—164; we will ask you to read the other.

A. Do you want it read in German or English?

Q. English; my German is a little rusty.

A. "The cast-iron form lies 14 inches from the horizontal surface of the forehearth. The cast-iron form is the tuyere, I should judge." The hearth of the furnace is made of sohlstein or granwache, a certain kind of stone they used in Germany. The hearth of the furnace is built of this certain kind of stone, granwache; there is no English translation of it. This merely speaks of the construction of the bottom in regard to (?) moist.

Q. Is that what you read on the next page?

A. I don't know that this over here has anything to do with any furnace; I don't know that it has. This other I know, because it refers to the exact figure.

Q. Read it; let us see?

A. "The arrangement of this furnace is shown by figures 858, 859, 860."

97 Q. Read on, if you please.

A. "Figure 860 represents a vertical section from the tuyere to the front wall. Figure 860 is the one which represents a section of that model, represents a vertical section from the tuyere. It does not say through the center of the furnace, but it is through the center of the furnace." The form, which I will translate as tuyere, is fourteen inches above the horizontal surface of the forehearth. The height of the shaft from the form to the feed door is fourty-four inches, Kallenberg's measurement. That measurement is a little different from ours; I don't know what it is. The inclination of the wall, the tendency to go out as it reaches the top of the furnace wall on the side is the same, as can be seen from the drawing.

Q. What you have read is the shaft, is the same width on the front and on the back, and the depth from the tuyere to the front wall is fourteen inches. Now read lines 13 and 14, start at 12.

A. Figure 859 represents a front view. The arrangement of this furnace is the same as the high furnace (the Germans distinguish between the low and high furnace), is the same as the arrangement for (?) schlichschmelzen for concentrates.

Q. This furnace, cut 860, you have read a description of that so far as to classify its character; it was for concentrating matte, etc.; it was reverber-tory?

98 Objected that it don't make any difference what the furnace was used for. Obj'n overruled.

A. Not at all; it goes on to tell what it was.

Q. Do not the two lines, 14 and 15, you have read say that this furnace has the form and construction of a furnace that is practically used for concentrating, smelting reduced matte?

A. It don't say matte—just as we have in Colorado here to-day. It is ore with too much sulphur or arsenic in; we roast it out, and then smelt it out.

Q. Read on page 164, if you please, lines 3 and 4.

A. "This arrangement is as a sump furnace with an open breast and with a tap basin.

Q. What does that describe—what figure?

A. It does not give the figure here—850.

Q. Are not furnaces made up in the bottoms for different purposes? State whether, if you was going to reduce litharge, you would make a different bottom from smelting ore, or if you were going to reduce matte you would make a different bottom.

A. Not that I know of. I never smelted any litharge. I don't see why you should use any different.

Q. In those two lines you have read it says this furnace has an ordinary tap hole attached to it, and the cut shows it?

Ans. Yes; it is a tap hole, and we know they tap the slag over this basin; the metal came out of that lower hole.

Q. How did they get it out of the forehearth?

A. They tapped it out, if the- chose to.

Q. What do these figures, representations, show they did?

99 A. That they tapped it out.

Q. This figure showing the different portions of the furnace, section views, and horizontal views, represents a furnace with an old tap, canal, and basin, such as there has been so much said about?

A. No, sir; it does not, anybody can look at it and see what it means.

Q. Is not there an old tap canal?

A. The metal is not tapped, as in this case, from the interior, but draw- out automatically and tapped from that outside basin, drawn out into this basin, and then tapped from that.

Q. That is to say, that when they operated this furnace, that you claim as represented by figure 860, described in page 164, they operated it by attaching to it this forehearth, an old tap canal and basin.

A. Yes, sir.

Q. That is the way they operated that furnace?

A. That is the way they operated that furnace, if they chose.

Q. Is not that the way Karsten represents it by description? H- says if you do not wish?

A. So far as this page is concerned, he does say that it is tapped off.

Q. So that the figures that I now call your attention to, 860, pages 163 and 164, in volume 5, of Karsten, do represent a furnace with a foresump or forehearth and inner-hearth, divided by a brasque partition?

A. Yes, sir.

Q. And the molten masses, by the Karsten system or representation, run into this forehearth, and then are tapped by an old tap canal or basin?

A. Tapped out by any canal or basin.

100 Q. (Give me volume three.) So that in this case they have, the system was under Karsten, to attach an old tap canal and basin to this lead-well for the purpose of getting metal?

A. If they chose to.

Q. Will you please read from volume 3, on page 318, what you did read?

A. Yes, sir. A sump furnace is a shaft furnace of which the hearth is partly inside and partly in front.

Q. That is to say, this is considered all one sump, divided by a partition, part inside, part out.

A. You may consider that one, with partition, he calles it a tap. "The slag runs off itself, over that forehearth; over it, not in. He says over ueber. It means not in there; over it. That being full of lead, that side would run right over it."

Q. The way of operating this was to fork off the slag, you think? He say- here he dips out the metal.

A. "Sometimes these furnaces have no tap basin, and then the metal is dipped with ladles out of the forehearth; that is to say, out of the sump, we might translate basin." That is to say, out of the basin in front of the furnace.

[Q.] What does it say there?

A. From that description alone, without a single darwing, I could construct a furnace.

Q. You have done it?

A. Yes, sir.

Q. What do you understand in these books, or in smelting, when you say forehearth or foresump?

A. Well, it is, with the German writers, rather indefinite; they sometimes translate it as though it were projection; some seem
101 to call all this front part in front of the furnace the forehearth; some writers seem to call the whole that. He says it is that projection, the forehearth, is the front, namely, that projecting portion of the furnace in front of the breast. That is as good a translation as I can give. It might be any portion of this. When he says the slag runs across the forehearth, were it not for this hole here, we might infer he tapped it here.

Q. I ask your opinion from your practical knowledge as a smelter whether a furnace has ever been operated practically, to your knowledge, with that three-inch open eye kept open all the time?

A. No, sir. I don't think so; don't think it could make slag fast enough to fill that.

Q. Let me ask you, if you should construct a furnace according to the description on page 318, describing Lable XXI, figure 473, if you would not have an open eye three inches.

A. Well, I have not made measurements. That furnace, as I said before, is merely an ideal representation. He give- a description here, and he says, Here is an ideal representation.

Q. So that you- opinion is that that furnace has never been practically operated?

A. Well, a furnace similar in character has been operated; that furnace has been operated.

Q. Is not that figure 473 representing this sump furnace the only figure in the whole Kansten's book that represents a furnace that has not an old tap canal?

A. Well, I am not prepared to say it is not; not prepared to say the contrary. I say that that furnace alone would correspond to the description.

102 Q. Except that this furnace has a tap canal and a tap basin attached to it to draw the metal out of this forehearth?

A. I said when I first started I didn't believe the Germans operated it as we would to-day; but they have left it on record, with descriptions—can produce the result.

Q. On what page of that book do you find the description of this furnace?

A. I say it corresponds practically to this description, that is, a description right here of a sump furnace; I can read this description; any man can recognize it from that description, just as a man would recognize your photograph hanging on the wall.

Q. If you construct a furnace having that eye open, do you think it would operate with three inches left open?

A. With three inches, even an inch and a half in any furnace, it would not run six hours.

Q. Does not Mr. Karsten say that the slag in this ideal furnace runs off from this upper eye—always open eye—in so many words?

A. I don't think he says it here, in speaking of it; but over on page 320 he says the slag runs of- constantly; a sump furnace with a covered eye, in which the brasque under the front wall divides the same into two communicating vessels, the slag runs off through the constantly open eye between the front wall and the brasque. People use this kind of anarrangement when they wish to dip the metal off clean.

103 By Mr. MACON: You were asked whether a furnace constructed with a three-inch open eye would work?

A. He does not say a three inch.

By Mr. SYMES: Did you not say it would freeze up in fifteen minutes?

A. I would not say 15 minutes.

Q. Say ten hours?

A. Karsten does not fix the size of the eye.

Q. Is not this figure drawn to a scale?

Objected to, because not cross-examination.

Judg. GRANT, of def'ts' counsel: We rely upon the description in Karsten; all the plates in Karsten which show the manner of withdrawing the lead.

The COURT: As a matter of fact, the size of that exit does not affect the question in any way. If the drawing show- an exit which is so large as to operate badly, and any one discovered that in operating it, and reduced the size of it, that is enough.

Q. I will ask you whether or not this 473 simply represented an

ideal model. This model, you say, represents a furnace, figure 860. Do away with this ideal concern and get to the other figure. Do you say that this model is built upon a scale similar to that?

A. I gave it to a mechanic; gave him a drawing similar to that; told him to build it of the proportions inside, especially that canal and the outside basin; and I asked him if he had
104 done it. He said he had. He had nothing else to go by but by that drawing; he had never seen it before or heard of it.

Q. All we care fore is whether or not — two or three lines you have read on page 164 (I think it is), volume 5, page 163, is the description that you introduce here for the purpose of showing that it is like the specifications of Keys & Arents to their lead-well?

A. No, sir; I didn't read it with that view at all. I read it merely to give the dimensions of the furnace and to show how I get at the depth of this lead-well. He doesn't give dimensions. 42 inches from here to here, 14 inches down to the level of the top—I only read that to show he gave some dimensions. When I built that furnace at Leadville I used that volume and this cut.

Q. Is there anything you have read in the description of this furnace 860, speaking about this forehearth as for the purpose of drawing off clean metal?

A. No.

Q. Does it not say, do you not understand, that forehearth to be fore the purpose of receiving all the metals; does not the figure of the tap hearth, the basin that is attached to it, for the purpose of drawing off the clean metal, after you get all the molten masses in there?

A. It shows by all the drawings that the metal is separated from slag by means of coming in through a hole rising up in the basin; after getting there it is tapped out into another basin.

105 Q. This partition between is brasque; that is, temporary in its character.

A. Not necessarily; it might run in there three, four, five, or six months. Any furnace is temporary and bound to wear out in course of time.

Q. That brasque partition extending down there, in the language of Prof. Karsten, separating the inner crucible from the outer crucible, is made of brasque, and would last probably a week or two?

A. Should judge a great deal longer. It was made at that time—the bottom of the furnace was made. I have worked a furnace several months with nothing but brasque between that lead-well; only seven or eight inches. This slag does not affect it very much. The molten metal would —— it quicker in this case than it would in that.

Q. Would not that little temporary partition, with the molten lead and slag on the side of it—the speiss and matte—wear it out in about days, while that might last two years; wouldn't there be that proportion?

A. I worked that furnace a week; there was no sign of burning out when I blew it out.

Q. Four or five days?

A. Of course not as substantial as we make them to-day, because we make them of brick.

Q. Is not there this difference, that the tap C of the Keys and Arents lead-well ascends, and this is a temporary partition; isn't there that patent difference?

A. I don't say it is temporary. Your witnesses have all testified here, by the way, that the Keys and Arents tap furnace will
106 run from twenty to thirty days; there is no use for anything in smelting that won't last a year.

Q. You think this would?

Objected to, as immaterial; has nothing to do with the principal of its operation. Objection overruled.

A. I want to say in the time this furnace was described, as far back as thirty, forty, and fifty years ago, in most of the smelting, they never had long campaigns; if they could get enough ore—two or three hundred tons of ore—they would fix up for three or four weeks; they had no occasion to make furnaces substantially as we make them now.

Q. If a furnace is constructed to-day according to that model, and the description according to that drawing and this model, do you think it would not freeze up in a few hours; I believe you said it would freeze up in a few hours?

A. No, sir; I did not say that.

Q. That was drawing 473; how is it about this model which you say represents 860?

A. I worked it up at Leadville; it worked all right; whether the hole was a little smaller or larger than that I don't know; run it a portion of the time open, a portion of the time closed.

Q. Now, I want your opinion whether a furnace constructed according to this cut 860, will, if you have the ordinary slag tap or slag eye different from this, constructed differently, the ordinary slag tap, so that the slag wont run out, that it would not allow molten speiss and matte and slag to get into that forehearth.

A. Not until you get sufficient pressure on there to press
107 out all the lead, which you can do very readily either with that or this.

Q. You say you can take that furnace and move your slag hole or eye over to there, the other side of that forehearth, and tap your slag there in the usual way, and that then, when you have done that, molten lead, speiss, and matte will not continually work into that forehearth?

A. Yes, sir; I said the speiss and matte will not come in; that it will go out with the slag; keep the pressure on you push the lead out.

Q. Do you say you can keep it out?

A. Yes, sir; I can keep it out.

Q. Is there not this difference between the Keys & Arents lead-well and this model, 860, that the molten masses run from the in-

terior of the sump or hearth into the interior of the forehearth by gravity, and in the other case it ascends through the tap C?

A. In one case it ascends, and in the other runs out on a level; a horizontal tap, going by gravity. There is one we worked three months; never got any matte or speiss in it.

Q. Suppose this should get clogged up with cold lead, is there any way to drive a bar through it and get it out?

A. Yes, sir; in all the furnaces made in Leadville, made by Frazer and Chalmers, they have an opening in the iron righ- here, and if this furnace should get clogged up in this tap, we simply cut out this clay here, drive right through into it with a sharp bar wherever the lead-well is.

Q. You would have for that purpose to open this and dig it out; it would be a good deal of work?

108 A. Oh, no; not much; this lead-well constructed according to Keys and Arents, with the ascending tap on the slant, you can't keep clean; sometimes you have to open it with a red-hot bar; have a succession of bars, one after another; heat them up and drive them in.

Q. You have to have them open?

A. Well, a little clay, that is all—fire clay.

Q. This is not the model that you used here, as being the Karsten furnace, with the modification, making a lead-well before?

A. No, sir; they were sent up the golden school of mines a few days ago; only a few days ago had this one made. It shows inside there the same thing, practically it is the same; this well may be a fraction lower, shallower; may be a little different from here to there. The other one I made or had made; this time I made it so it would illustrate the thing better.

Q. The reason you claim this forehearth is substantially the Keys & Arents—operates upon the same princip*al*?

Ans. A. Simply because there are two vessels, one on the inside and one out, connected by means of a tap. I claim (?) slag tap runs through the slag basin and also into it.

Q. You propose to change it and put it to one side?

A. Yes; Keys and Arents change the well from the front to the side; now we propose to change it there.

Q. I have shown that this model [is] not provided with an old tap hearth—(?) Karsten—that old tap basin is not attached to the furnace?

A. It is not necessary to give that more than a slag pot;

109 we catch our slag to-day in the slag pot. You must remember here are two different things altogether; here is a crucible furnace; the metal runs immediately from the interior of the crucible into the outside basin here. The metal is withdrawn from the furnace into an outside basin and then is tapped from that outside basin; that outside basin is called a forehearth or forecrucible, divided by a partition from the inner crucible.

Q. That forehearth received into it all the molten masses that other receives into it?

Q. I say, according to the description and cut in Karsten, does it

not; answer that questson? According to your model itself and the cut in Karsten that forehearth receives into it in the ordinary course of smelting all the molten masses?

A. No, sir; a portion would run out there.

Q. The Karsten furnace, with its forehearth built and operated according to figure 860, will not produce clean metal in the forehearth if you leave that tap hole open?

A. It will not, if you close it; just as Keys and Arents took the lead-well from there, put it in the front, you would get the slag mixed with the metal there.

Q. When you operated your furnace at Leadville you say you let the slag run into that forehearth and then took it out with a fork part of the time when you were operating?

A. Yes; part of the time.

Q. You considered that operated like Keys and Arents lead-well?

110 A. I considered we got clean metal from that furnace. The slag chilled on the top of the lead; we threw this cap off, and the clean lead was right under the chilled slag.

Q. Doesn't Mr. Karsten say in his book the slag will run through either the open or upper eye—both?

A. He says you can run it there.

Q. Have not all the furnaces operated in Germany, to your knowledge, or described in any book (not ideal), alwa-s received into the forehearth all the the molten masses through the hidden eye, and haven't they had an open eye or slag eye.

A. Don't think they have, judging from the description seen in the book. He particularly says, speaking of the second hole, the only object it has is the withdrawal of the slag. Right here, 320, he says: The slag can be carried through the covered eye into the forehearth, or we can use a second open eye above the forehearth, the only object of which is the withdrawal of the slag which accumulates in the furnace.

Q. That is the ideal furnace?

A. That is another figure he gave to represent a furnace with communicating vessels. Of this furnace the two vessels are practically the same; there is a partition separates the outside from the inside of the basin; the principle of communicating vessels is the same, whether applied in that furnace or the Keys and Arents. It is through that partition we effect the separation of the slag from the metal.

111 Q. It would not be practically the same if there were no partition there?

A. No; I would not say it was the same if there wasn't a partition there.

Q. That would be acting upon a different principle, and not mechanical construction; you would not necessarily separate your slag; if you were to take out that partition there, of course, all your slag and everything would run right into that outside basin?

A. As long as there is a partition, as long as this hole is at the bottom, you can separate lead from slag.

Q. If you construct that furnace according to your idea, any way you please, if you construct that furnace in the ordinary mode of an open hearth sump furnace, and leave the partition out, could you construct and operate it, as the only evidence shows they have offered. Then is there any particular difference?

A. Yes; if they took out that partition there would be.

Q. That is not practically the same?

A. It is not practically the same.

Q. Then I ask you whether to your knowledge there has ever been operated in Germany anywhere, or built from that ideal drawing and description of Karsten, a furnace at all, practically operated?

Ans. Of that kind, we can do it, if we want to, showing that he is familliar with those things; that the principle of communicating vessels, and withdrawing metal automatically, was not unknown to him. He says if smelters want to do it they can do it. If you
112 want to dip it out you can do it.

Q. Governor Grant, was it considered an improvement now, in your opinion as a practical smelter and educated metallurgist; was it considered an improvement on this old sump furnace, with this partition in it here, to attach to it as there is attached there, an ordinary tap, hearth, and basin, to draw off the clean metal, over forking the slag out of the forehearth, and then ladling the metal out of the bottom?

A. Yes; that is an easier way of removing the lead from the furnace.

Q. That was considered an improvement?

A. Yes, sir.

Q. So that this figure 860, which you say is a real furnace, you have a real model of, with tap, hearth, and basin attached, is in your judgment an improvement over the ideal furnace you have read about on page 320?

A. I don't say that; I say the ideal furnace here described implies all that is in existance to-day in the smelting, as in the model; the metal was ladled out; clean metal; he provides for the disposition of the slag and the metal; in this description here, in speaking of the smelting furnace, and the methods of smelting in those days, it shows that the principle of withdrawing lead in the first place automatically was not unknown to Karsten; it shows the method of removing lead by ladles from this basin or sump in front of the furnace was not unknown to Karsten.

Q. Has there ever been a time in the earth's history, since
113 we took back to smelting, when the metal was not ladled; was there ever any other way of taking *to* from the sump or basin but with a ladle?

A. In that furnace of Karsten's it shows the metal went automatically, of it- own accord, from the interior basin to the exterior basin; it run- through under there. He does not say, in so many words, it rose in the basin; the mere words, it was dipped, shows *shows* it did rise.

Q. You imply the slag would come in here?

A. No. In that case separated from the slag in the furnace, separated automatically.

Q. Is the object of that forehearth at all to collect the clean metal alone; and had it not other objects?

A. I should say it had no object, except the collection of the metal; the withdrawing of the metal from the furnace; and my opinion is that the Germans ran the slag over that metal, because they thought that the lead being exposed there would oxidise a great deal, and then the slag, always a few particles of lead—supposed it might catch those particles of lead that dropped down in that basin.

Q. I will ask you to read on page 186 and 187, vol. 4 of Karsten, and if that is not the only place in the work where he talks about lad-ing out; and if that does not apply to iron furnaces alone for small castings?

A. Well, he says the furnaces in which the *flag* does not fllow off,
but it is lifted off. It merely says that a furnace which gives
114 slag; rich with iron in that case it is not dipped out with
ladles, as I understand it. You ask if that is not the only place he speaks of dipping out with ladles; I will say it is not. That was an iron furnace; it was not applied to lead smelting. We have shown here that this furnace is applied to lead smelting—that one. Mr. Karsten says you can use it or not, as you like; he says you can dip the metal out of there.

Q. When he says that it is the theory part of his book, in general metallurgy, he does not say a furnace has been operated practically that way. (?) The cut shows there was an old tap hearth?

Ans. This general description is applicaple to any furnace that corresponds with this description. I can point out every point on that; and any man can see that it corresponds to this description.

Q. The question is, was it ever practically operated?

A. We don't know about that. That dosn't make any difference; the question is, can it be done.

Q. I believe you said attaching the old tap hearth and basin, as it is actually done here in the figure your model represents, is an improvement on the dipping it from the forehearth?

A. If I said that, I don't remember it.

Q. You don't think it is?

A. Whether I think this method would be an improvement over that, that is the question.

Q. Over the way Karsten——

A. It would be an improvement over running the slag into your
lead-well; it would not be an improved method of withdraw-
115 ing the molten metal from the interior, because this just as
effectually withdraws the metal automatically from the bottom of the furnace as any method in the world.

Q. What is the reason in your opinion, then, as a practical smelter, that every furnace for the last fifty years, at least, has had the old tap hearth and basin attached to it for the purpose of withdrawing clean metal; that it has not been done in any other way until 1871, when the lead-well was invented?

Ans. Lead smelting was not carried on to any great extent until 1869 or 1870; lead smelting was not carried on in blast furnances

outside of Germany; that was the chief center of smelting in blast furnaces.

Q. That is what I understand?

A. Notwithstanding this is claimed to be so great an improvement in the five or six smelting furnaces in Freiberg, I have not seen one of these Keys and Arents used there at that time, 1876.

Q. You don't think it is an improvement any way, do you?

A. I think on certain characters of ores.

Q. Do you see any other kind used here?

A. All the ores we are smelting are pretty heavy in lead, suitable for withdrawing lead automatically by means of communicating vessels, one on the inside.

Q. You never attempted or expected to run a furnace like the old Karsten furnace, with a metal forehearth?

A. It is practical in some cases (?) profitable as it is used in the Robinson furnace; use the forehearth with——

Q. Is it not the ordinary Pilz furnace?

116 A. They don't use them at Freiberg; this furnace here; if this extended a little further, had a partition down in there, it would represent this. If that partition was there, and a hole at the bottom, you would have that forehearth partitioned off; you would have two communicating basins; there is certainly nothing new about two communicating basins—nothing at all; there is certainly nothing new about a tap; nothing new about its application to a blast furnace to withdraw metal to the outside basin.

Q. There is nothing new about the principle of liquids in two communicating vessels?

A. No; there is nothing new about the application, except the incline; it was never applied to a blast furnance in an inclined shape; it was applied before that by a straight tap communicating.

Q. You have said you didn't know it was?

A. I don't remember.

Q. You didn't pretend to say it was practically operated?

A. I may have said it, hurriedly. I didn't think. I say the principle of communicating vessels was known to Karsten, connected by a straight tap leading from the ——. I don't think I said I didn't know anything ——

Q. I ask you if you did not say that furnace described on page 473, you didn't know had ever been practically operated?

A. I misunderstood you. This furnace here shows that it had been worked; I said I didn't know that they have ever worked it so as to tap the slag off from any other portion, except the
117 front. I don't think any lead furnace in Colorado would operate with a three-inch opening for the slag to run out of.

Q. Wasn't it considered quite an improvement in furnaces when they removed that inner partition and had the forehearth not sepated by the partition from the inner hearth and drew the metal out by a tap?

A. No; I don't know that it was.

Q. Isn't it supposed that this old primitive furnace, in this form described by Karsten, had a forehearth and partition between for

the purpose of ladling out the metal, separating it, after it run into it; the molten metal by which the slag could be skimmed off; the speiss and matte skimmed from the bottom — lead furnaces produced in those times?

A. I should judge the furnaces operated just as he describes; the metal flowed out from the bottom; they tapped it from near the bottom, judging from the drawing, and drew the metal off into an outside basin, and dipped it off from that outside basin.

Q. I want to know if you don't think, as a smelter, familiar with the history of smelting, that this old Karsten furnace that is described and partially imitated by your model, that this forehearth part of it, in the first place, was used for the express purpose and invented for the purpose of letting all the molten masses run into it before they had forehearth basin pitched off?

A. That is what I think—that is what I think they use for a different purpose.

Q. State if you don't also think, from your experience as a
118 metallurgist and familiarity with the history of smelting, that when they removed this partition and kept the whole crucible, inner hearth and forehearth together, and tapped off the metal after it settled by an old tap hearth and basin, that that was considered an improvement on this old ideal Karsten furnace?

A. I say an improvement for certain things; when you wanted to clean off the bottom it would be better not to have this partition in here; for certain purposes in others it is not — going to show here; if you accumulate these accretions on the bottom, to get them as they did in old times, better to have that partition, if you want to separate your metal.

Q. If you want to run it like that, that would be an improvement on any other mode?

A. That would be, in some respects, an advantage; in some a disadvantage; I don't say in all respects it is an improvement.

Q. Is it not a fact, in you- opinion, from your knowledge of the theory and your practical smelting, that there has not been in the last fifty years a smelter operated either in Europe or America with a forehearth without the old tap canal and basin attached?

A. None, so far as I know of.

Q. Is it not a fact, then, that in the last eleven years the Keys' & Arents' basin connected with the bottom of the main crucible or fore crucible is the only method that has been practically in use?

A. I didn't finish answering the other question.

119 PLAINTIFFS' COUNSEL: The witness was going on to make a speech.

The COURT: I don't think the witness has any advantage of counsel in speech-making. If he keeps even with you he will do very well.

—. If you call the Keys and Arents furnace merely a furnace working on the principal of communicating vessels, then I will say no other furnace but that; but when you take into consideration that — Karsten furnace had two basins, one inside and one out,

could not answer the question and say no furnace, — all these furnaces, as this one of Karsten.

Q. The question is, whether or not, during the past fifty years, in your opinion, from your knowledge, and we admit it to be very great—in your opinion, there has been a furnace practically operated (before 1871), except by having a tap hearth and basin, for the purpose of drawing off the clean metal?

A. Then I would say there had not been, so far as I know.

Q. Since 1871, is it not a fact that the Keys and Arents lead-well for the purpose of drawing off the clean metal has been the prevailing method of smelting?

A. In some countries it has; through our country. It has not been used extensively in Germany.

—. Do you not know it has been regarded by the leading smelters as an improvement?

A. Yes; it facilitates the removal.

120 Q. Do you not think it a greater improvement on skimming out speiss and matte?

A. Yes. If I didn't think of running my furnace, running slag over that well, I can do it.

Q. Of course you can. If you want to keep on smelting like fifty years ago, you can do it. There is a great difference between a "sow" or "bear" falling down on the bottom of the furnace and attaching itself, and an accretion that forms and floats on the lead bath, in the trouble of removing it?

A. It is the same material.

Q. Does it not come from different causes?

A. In what way; what — come from?

Q. If the raw ore, assisted by all the lead being there, suddenly drops down upon the hearth of the furnace, is it not very likely to attach itself and form an accretion, when, otherwise, mere chemical combination would not do so, if it remained on the lead bath?

A. No; I don't think it would. When it once fell below the tuyeres it would be very difficult to get it out anyway, whether it rested on the lead or on the bottom.

Q. You don't agree with the witnesses in these depositions, that accretions are prevented by the plaintiffs' invention?

A. I agree with them to some extent; but I don't agree that we are indebted to Messrs. Keys & Arents for keeping lead on the bottom. Here is the old Scotch hearth. We are not indebted to the lead-well for that improvement.

Q. Is the old Scotch forehearth or Scotch hearth a blast furnace?

A. Yes, sir; they use blast in them to-day.

Q. Is it a blast furnace, technically?

121 A. They use the hot blast. They are described in the books on metallurgy the American or Scotch hearth.

Q. State whether it is considered in metallurgy a blast furnace?

A. I would say in metallurgy any furnace with forced blast, sometimes in reverberatory furnace—in any shaft furnace.

Q. Are you stating your own opinion, or what you have learned from books?

A. I am stating my own opinion; any shaft furnace with a blast blown in; any smelter understands.

Q. I am to regard all you said about it simply as your own opinion; it does not agree with books or lectures in Germany.

A. I don't say that it will; I say any smelter or metallurgist, any honest, conscientious one, will look at it, and, seeing this model, will say he can, by means of this furnace, with his melten metal from the bottom of the furnace by means of an outside basin.

Q. Do you think a lead-well formed just in the form of the Keys & Arents would ever have been attached to your furnaces by your study of Karsten if you had not seen it practically in operation before?

A. It may have been done. Mr. Boyd testified it worked now in Europe; I wish he was here now; wish he was a witness.

Judge SYMES: There is a witness here who taught him all he knows about smelting.

Re-examined by Mr. MACON:

You were asked when you saw Percy's book first; I under-
122 stood the latter part of 1880?

A. If my recollection serves me now, it was in '80.

Q. It was the description in Percy's book of Karsten's furnace that led you to investigate it?

A. Yes, sir; that led me to investigate it; it took some time to get these maps; it took a long time to send to Europe. It was first called to my attention by Prof. Pearce, of the Boston & Colorado smelting works.

Q. You said you built a lead furnace in your works after the model of Karsten, and after the description in plate 860. You were asked why you did not continue to run it; it was a mere experimental furnace, to test the accuracy of that description, was it not?

A. That was all.

Q. You had all the furnaces built you wanted; didn't want to go to the expense?

A. I built that furnace simply for the purpose of seeing if it would work satisfactorily, act as Professor Percy said it would; did it with a view of using it as testimony in this case.

Q. You were asked very frequently, and in a great many questions, whether or not, even in the Karsten furnace, as described in plate 860, there was not a lead basin into which lead was withdrawn from the outside crucible; you said it was; is that any part of the furnace itself?

A. In that particular instance I would say it was detached from the furnace; sometimes the kettle is put right down in the sand; at other times, as I have seen in Freiburg, they have a kettle on a railroad.

123 Q. Is it any part of the furnace at all?

A. It is not a portion of the furnace, not necessarily, according as the builder of the furnace may choose.

Q. They have asked you to read from volume four; they have

asked you if it is not the only place where mention is made of ladling metals. I ask you if there is not on page 320, third volume, an allusion there to ladling metal clean, if they chose so to do it, instead of tapping it out?

A. Yes.

Q. You say, so far as you know, Karsten's furnace has not been used in the last thirty or forty years; do you know that it has not been?

A. No; I do not. We sent to Europe for Percy, also for Karsten; had copy of it here; sent also and got another copy.

124 The defendants, to further maintain the issues on their part, then called as a witness Professor BIEGER, who, being first duly sworn, testified as follows:

Q. What is your business, occupation, or profession?

A. Metallurgist.

Q. Where were you educated?

A. The mining school at Freiberg.

Q. When did you leave that university of Freiberg?

A. In 1842.

Q. Have you practiced your profession ever since you have been in this country?

A. Considerably in this country since 1867.

Q. Have you had any charge of smelters in this country?

A. Yes; I was with the Boston and Colorado smelting company at the start; then I had been in the Dudly; then in Geneva Gulch; I started a furnace there.

Q. You think you understand the art and science of metallurgy, do you?

A. I believe I do.

Q. Do you understand also the construction of furnaces—smelting furnaces?

A. Certainly; I have built them.

Q. Where did you build in this country?

A. In this particular State—in Colorado.

Q. In what particular place?

A. At Blackhawk, Dudley, and Geneva Gulch; I built one at Gothic, Gunnison.

Q. Did you have charge at one time of the Boston smelting works at Alma?

A. Yes; I think I was four years or six year- in Blackhawk.

Q. With the same smelter, the same company, in Blackhawk?

A. Yes.

125 Q. Are you acquainted with the standered authorities on metallurgy of this day?

A. Certainly.

Q. And the old authorities?

A. Yes, sir.

Q. Are you acquainted with the works of Karsten, called his system of metallurgy?

A. Certainly.

Q. How long have they been published and sold in book stores?

A. They were sold when I was at the mining school at Freiberg; in 1838 and 1842 you could buy the books.

Q. Was Karsten an authority in those days on the subject?

A. He was very high authority, indeed, considered our greatest metallurgist at the time.

Q. You have seen it on sale in the book stores in this country?

A. No; I don't think you would likely; have got to order it on purpose in New York; you could get it; you could not expect to see it.

Q. State whether you have ever seen a description of the furnace given by Mr. Karsten which resembles the smelting furnace of this day with the Keys and Arents' attachment?

A. It don't go under the same name. He gives a furnace similarly in principle; gives a drawing of it, and says it has been used for certain purposes.

Q. You are familiar, are you, at this time, with the drawing which represents the furnace that Karsten described, which I asked you if it resembles the Keys and Arents' attachment?

A. It is the same in principle as the Keys and Arents' but different in arrangement by getting the slag out on a different side of the furnace.

Q. You are acquainted with the drawing which Karsten gives?

A. Perfectly.

126 Q. Have you ever seen a furnace constructed upon the drawing—by that drawing?

A. I have not seen it myself, not exactly.

Q. Did you see one in Grant's smelter constructed upon the model given by Karsten, and the description?

A. Yes; I have.

Q. Did you see it working?

A. Yes; it started on the 17th of October, I believe, in 1881. The furnace started on Monday, the 17th of October, 1881, at 11 a. m.

Q. Describe how it worked, that is, how the lead passed from the inside crucible to the outside lead-well?

A. It passed by a communicating opening at the bottom.

Q. Does that model there resemble it any?

A. Yes.

Q. Is it an exact representation of it?

A. I should think so; the lead flowed from the bottom in there; the slag flowed in different ways; the eye of course was here, right in the middle; he had it flowing right over it by making a gutter of sheet-iron and a turn around here; in that way it flowed most of the time.

Q. You are familiar with furnaces using the Keys and Arents' attachment?

A. Yes.

Q. State to the jury in short what is the difference between the Keys and Arents' attachment and this furnace?

A. This Keys and Arents' attachment instead of letting the slag run out here on the side——

Q. What is the difference in the channel?

A. In Karsten's it is inclined; it extends further out.

Q. Does it make any difference in the principle upon which they work?

A. No; the principle of communicating vessels is the same.

127 Q. Whether the slag runs into the lead basin or not depends on the choice of the smelter, does it not?

A. It depends on the choice of the smelter. He can put his slag-hole anywhere he pleases.

Q. Did you ever see a furnace built upon that model working; did you ever see a furnace working upon that same principle in actual operation before 1871?

A. They have furnaces working in the south of Spain on a somewhat similar principle, taking out clean metal, running out slag.

Q. Is the principle the same or is it only similar?

A. They have got the same principle here. They left the slag run right over the lead basin here, but they keep, between the lead basin, the level of the clean lead, and between the level of the slag keep a layer of cinders, over which the slag runs, which forms a kind of filter over which the metalic lead can filter. No lead will run out as it is in the Arents furnace. That has been a long while in use. I was down in Spain—I should think the south of Spain—somewhere in 1865.

Objected to, by plaintiffs, because immaterial.

Defendants' counsel intends to show prior use.

PLAINTIFFS' COUNSEL: As this has no application to anything that is pleaded, I move to strike it out. We never heard of it before.

THE COURT: There may be some question as to whether this Karsten furnace has been in use anywhere. I understood counsel to take the position it had never been used.

128 To which ruling of the court in overruling said objection plaintiffs, by their counsel, then and there duly excepted.

Q. Before 1871, were the furnaces sometimes provided with two metalic eyes, one higher than the other, so as to tap from the higher one and have always a bath of lead below?

A. Well, those furnaces I have seen only had one tap; they may have several taps, but practically on the same level.

Q. I understood you to say that this experimental furnace built by Mr. Grant worked well and regularly?

A. It worked regularly; made clean slag and clean metal.

Q. When you studied metallurgy and practiced it in the early days in Germany and this country, the furnaces were smaller than they are building now, were they not?

A. Oh, yes; very much.

Q. And up to within the last twelve or fourteen years furnaces were more perishable than they now are?

A. Certainly.

Q. State the cause.

A. Because we had no water jackets. The heat would smelt out

the bricks, which the water jackets prevent. For that reason they could not have a large furnace.

Q. When you first begun to learn and practice your profession crucibles were always built of brasque; latterly they have been built of fire-brick?

A. Lately, yes; it is the water jackets that preserve them. The water jacket has made all the changes.

Q. As a practical smelter and scientific metallurgist, do
129 you think that the Keys and Arents attachment has any effect towards preserving a furnace?

A. No.

Q. It can't well have any greater effect than the lead-well described in Karsten's book?

Objected to, by plaintiffs' counsel, because—

But the court overruled said objection; to which ruling of the court plaintiffs then and there duly excepted.

Question repeated: Can the Keys and Arents attachment have any greater effect to preserve a furnace from destruction than this?

A. No; the well has nothing to do with the destruction of the furnace. In the Keys and Arents it comes up close against the wall of the furnace.

Q. In the Keys and Arents all that there is in their tap is simply in the lead-well being inclined down?

A. Yes.

Q. If the pressure is the same inside and out, it will be on the same level. Can you work just as large a furnace now by the old method of tapping from the bottom, in the old way, as you can work with the Keys and Arents attachment?

A. Why, certainly.

Q. Are they working as large furnaces in this country to-day, by the old method of tapping, as they are working by the Keys and Arents attachment?

A. That I could not tell you; I don't know of the working of any large furnaces; I am not acquainted with any in Colorado, to
130 my knowledge; I am not acquainted; there may be some working without the Keys and Arents attachment in Colorado. No, I believe those furnaces have not the Keys and Arents. Mr. Geist and Mr. Boyer use furnaces without the Keys and Arents.

Q. Are they large furnaces?

A. Yes, sir; considerably large furnaces.

Cross-examined:

Q. One of the leading objects of smelting is to get from the crucible of the furnaces, separate from all other molten masses, the clean metal?

A. Certainly.

Q. The molten masses, when they are first fused, are melted and drop-ed down in liquid form, are considerably mixed together un-

til they drop down, or until they are in the order of their specific gravity?

A. Certainly.

Q. The lead goes to the bottom of the furnace. Do you know how far back, from your learning in the history of smelting, it was that this old tap basin, tap hearth, or forehearth, whatever it might be called, where this partition was put between the same, was invented and operated?

A. You mean this one here, applied to an old furnace? That has been from time immemorial, I suppose.

Q. Do you not understand, that before this old tap canal, tap hearth, and basin was use- for the purpose of withdrawing metal from the sump furnace, as described in figure 860, was invented

131 and considered an improvement on tapping out of this forehearth of the old furnaces?

A. In primitive days where such small amounts were melted, to dip it out of this basin could be only done —— materials produced from laye or small quantity of metal —— most useful with large amount of lead it would be practicable.

Q. You would do it by taking a fork and pitching off, skimming off the matte and speiss?

A. You can do it in different ways; that is the way you can do it.

Q. So that if the furnace is constructed and operated exactly according to the description we have in Karsten, leaving off this tap hearth and basin that is provided, then in the ordinary course of that furnace all these masses will run into that forehearth and settle there as much as they did with the partition?

A. The heaviest part, of course, will go to the botton; no lighter can run to this basin as long as this vein is covered.

Q. Leave it according to the model, and the Karsten furnace with the upper eye open, as soon as it comes to the level of the upper eye the lighter stuff will run out. Now, was it or not the great object of the forehearth or foresump, which means simply the forepart of the sump of the crucible, divided to receive all the molten masses?

A. Some furnaces have got no forehearth at all.

Q. Then it was the inner hearth received that—the inner hearth received it all?

132 A. Nothing but the outlet of the slag.

Q. For the past fifty years, from your knowledge, has there been a furnace operated either with a forehearth or without a forehearth according to the exact description of Karsten or any other that they have not drawn clean metal from it only by an old tap hearth and basin?

A. Well, it was usual to dip it out, except to get it on the principle of the thing.

Q. Do you consider the old tap hearth and basin a better method of withdrawing the clean metal out of this forehearth of the Kastern furnace than to dip it out with a ladle after you get the slag out of the way?

A. It is the same thing; you can dip it out or you can ladle it out.

Q. I say, do you consider it an improvement in operating a Karsten furnace to do away with the forehearth. I ask you whether or not, as a practical smelter, in your opinion, it is an improvement to draw the clean metal from the forehearth of a Karsten furnace by an old tap canal or basin instead of ladling it out after you get the slag and speiss and matte out of the way, do you consider it an improvement?

A. I would ladle it out; some people tap it out the same as Keys.

Q. You have just said, have you not, that for fifty year, in your opinion, every furnace had been operated up to 1871 wit a tap hole?

A. You ask the question if the tap hole is level with the bottom; you explain to Colonel Macon the tap canal is always attached to the furnace.

133 Q. Do you consider that tap canal basin an improvement over dipping the metal out of the forehearth?

A. In some places they won't have the Keys and Arents at all.

Q. I don't ask you what they did anywheres; I asked your opinion; is it an improvement?

A. It is an improvement.

Q. You consider the Keys and Arents lead-well as constructed by them an improvement over the old mode of tapping?

A. Why, it is of course; nobody denies that.

Q. Do you think there has been practically operated for the last fifty years, in Europe or America, to your knowledge a Karsten furnace without an old tap canal and forehearth to draw the metal out?

A. I mention it; I think they could take clean metal out itself.

Q. I ask you if in your opinion, for the last fifty years, there has been a blast furnace operated in Europe or in America up to 1871, in which the lead, the clean metal, was not withdrawn from the inner hearth to the forehearth by an old tap canal and basin, similar to this one in principle. You can answer what your opinion is?

A. Well, not exactly on the same principle.

Q. You know what tap canal and basin is?

A. Certainly.

Q. You don't want to dodge the question; you can answer it?

A. Certainly; as I mentioned before.

Question repeated.

A. Well, yes; there is; it can; it has been done by the English slag hearth. They had the same in Spain.

Q. And in Spain you say they ladled it out?

134 A. No; they just get it in the foresemp, and tap it out.

Q. That is what I asked; are those the only exceptions; are those the only ones you know of?

A. The only ones I can answer.

Q. Have you examined this cut 860 carefully?

A. I think I know all the cuts, sir, pretty well.

Q. There is supposed to be 860. There is the ground floor. From that cut, if you was going to construct of furnace according to it, would you put an old tap hearth, tap canal, and basin attached to

this forehearth, if you constructed it according to that figure and the description of Karsten?

A. There is one here, of course.

Q. Then, Professor, if you constructed a smelting furnace with an attachment to withdraw the clean metal according to the figure introduced here and according to what they say this model represents, you will put a tap hearth and basin similar to this with this forehearth?

A. Not obliged to do it.

Q. Wait a moment; if you constructed according to the drawing one basin here and one canal; that is, the drawing applicable to the figure representing the different sections and portions of this furnace, is it not?

A. I suppose so.

Q. Then, if you constructed a furnace according to this cut 860, table 41, introduced in evidence here, as being like this model, you would attach to it a tap hearth and basin, would you?

A. Well, could not take it out.

Q. Was not it considered an improvement in the progress of smelting in Germany to have an open front furnace, and take
135 that partition out from the old Karsten furnace, was not that considered an improvement?

Objected to. Objection overruled.

(No answer.)

Q. State whether or not that brasque par-tion between the fore and inner sump and fore and inner crucible has not been left out in all furnaces for the last 25 years, as a general rule, at all these new furnaces at Leadville and other places?

A. Most of the furnaces they have the forehearth all one.

Q. Is that considered an improvement?

A. It is a matter of opinion.

Q. That is what I am asking, for your opinion; you are an expert witness?

A. I don't think it is a particle of improvement.

Q. You say in the sout- of Spain you saw a furnace similar to this; was it (refers to black-colored model)?

A. Yes, sir; something similar; put a layer of cinders between the lead, and let the slag run continuously over the cinders.

Q. You think that is like a lead-well?

A. Just such a lead-well as that is in the south of Spain.

Q. Until you found the lead-well would you be able to keep the slag off here—to take off the slag?

A. You can ladle it out or you can dip it out.

Q. You consider the Keys and Arents lead-well an improvement over having the slag run over the top out of the basin, and
136 then having to stop the slag and remove the cinders?

A. Yes; I do.

Q. You do; quite an improvement?

A. Yes.

Q. You have also seen a kind of furnace; where did you say—in England?

A. A slag hearth.

Q. What was this slag hearth used for?

A. To melt rich lead-slag.

Q. Was that slag hearth used for the exclusive and only purpose of withdrawing clean metal from the smelting furnace when in operation?

A. That was getting the slug out of rich lead for smelting in reverberatory furnace, making rich lead; they have to get the lead out of rich slag; that furnace was not used for smelting, or at all used for smelting very rich slag.

137 The defendants, to further maintain the issues on their part, then called as a witness — SMITH, who, being first duly sworn, testified as follows:

Q. What is your occupation or profession?

A. Smelter.

Q. Where do you smelt?

A. Leadville.

Q. How long have you been engaged in that business?

A. About nine years.

Q. Did you study metallurgy before you went into the business of smelting?

A. No, sir; I never studied it at all, except some time that I studied it practically.

Q. In the operations of smelting?

A. Yes, sir.

Q. What smelter did you learn in?

A. LaPlata Mountain.

Q. Large or small?

A. Six stacks—six furnaces.

Q. Do you know what this Keys and Arents attachment is?

A. Yes, sir.

Q. You know the principle upon which it works?

A. Yes, sir.

Q. Have you ever been in the Grant smelter and seen this experimental smelter that he built?

A. Yes, sir.

Q. Does that work upon the same principle the Keys and Arents attachment works?

A. Precisely.

Q. When you saw it was it working?

A. Yes, sir.

Q. Did it work regularly?

A. Yes, sir.

Q. Did it produce the same result, to wit, clean lead in the lead basin?

A. Yes, sir.

Q. And discharge slag in some other direction when it discharged

it from the hearth, lead-well, or forehearth; how much slag, actually, was deposited in the lead basin?

138 A. I could not say, but a very small quantity indeed.

Q. Was there any difficulty in controlling the direction of the flow of the slag after it left the crucible?

A. No; it could be turned into or out of the lead basin, as the smelter pleased.

Q. When it was allowed to run over or into or upon the lead in the lead basin, how did they get the lead out clean?

A. By removing the slag from the tap and bailing it with a ladle.

Q. Was the slag encrusted rapidly?

A. Not very rapidly; it hardened sufficiently so as to remove it.

Q. Have you ever worked a smelter where it was tapped from the bottom?

A. No, sir.

Q. You always worked a smelter where it was tapped above the bottom?

A. You mean the old style—the old tap; I never worked one of them; no.

Q. Did you ever see a furnace worked that way?

A. Yes, sir.

Q. Have you ever worked any furnace worked that way?

A. No, sir.

Q. Have you observed the operation of withdrawing metal from the furnace worked according to that model you see before you?

A. Yes, sir.

Q. How often have you seen metal withdrawn in that way from the metal tap at the bottom of the furnace?

A. I could not say.

Q. A great many times?

A. Not a great many times; got tired of it.

Q. Did you observe any difficulty in stopping the flow of the metal when the smelter desired to stop it?

139 A. I never saw any accidents; never knew of any.

Q. Are there not a large number of furnaces in this State now, which are tapped in that way, the old way?

A. I understand there are, sir.

Q. Take the furnace such as you worked, with the Keys and Arents' attachment, can you get all the lead out so as to allow the slag to run into the lead basin?

A. Yes, sir; that is done.

Q. In what manner, now explain it?

A. Well, it is generally done by incompetent men.

Q. How would a competent man go to work, if he wanted to get the slag into that basin?

A. By withdrawing the lead from the outer basin, forcing a quantity of slag, the weight of the blast against it. It is frequently done by careless men.

Q. Did you ever work in Utah, at a smelter?

A. Yes, sir.

Q. Did it have the Keys and Arents attachment?

A. A similar one.

Q. What was the difference between that and the Keys and Arents attachment?

A. Well, I would say that the one which perhaps you have reference to, had a straight channel from the bottom to the outer well, and the well was in the forehearth, near the corner of the furnace.

Q. The well was the fore hearth?

A. Not precisely; the well was in the forehearth, but to one side of the slag tap.

Q. It was on the same side the slag tap was, was it?

A. Yes, sir.

140 Q. It was substantially the Keys and Arents attachment, was it, as shown on the drawing?

A. I would not say it was, because the channel was straight from the inner well to the outer well.

Q. Did it work exactly as the Keys and Arents attachment does work, produce the same results in the same manner?

A. Yes, sir.

Q. The difference was, the channel was straight, and it was on the inside of the slag tap?

A. Yes, sir.

Q. Do you know whether the owner of that furnace paid any licence to Keys and Arents?

A. Not to my knowledge; we did not while I was interested.

Q. Were you one of the owners of the smelter?

A. Not an owner.

Q. Give the name of that smelter.

A. The American.

Q. What year was that?

A. 1878.

Q. How long were you with it, receiving a per centage of the profits?

A. I received a per centage of the profits for one year, or about a year and a half.

Q. Any licence demanded from you or your associates during that that time?

A. Not to my knowledge.

Q. Were Keys and Arents about there during that time?

A. Arents had been in the Territory previous to this, and was in charge of the Jordan and Golden works, had run works, my impression is, for a short time within 200 feet of our works.

Q. Do you pay a licence at the La Plata works?

A. Do we? We did.

Q. When did you begin to pay?

141 A. We paid a thousand dollars sometime, I think, in June, 1880.

[Q.] How long did you run that furnace before any demand was made for licence?

A. Possibly a year or so; probably a year.

Q. When did you commence running this smelter of yours, the La Plata works?

A. In February, 1879.

Q. Were Messrs. Keys and Arents there at the time in Leadville, or about there?

A. I think not, sir.

Cross-examination:

Q. What experience have you had as a smelter?

A. Nothing but practical.

Q. How long have you been smelting?

A. Nine years or more.

Q. You say that in this so-called Karsten furnace built and operated by Mr. Grant, as testified above, small quantities of slag continually drop into this forehearth or basin?

A. I don't think I said so.

Q. I understood you to say so; explain what you said?

A. Very well; in the slag flowing over the lead-well but a small quantity would rest there.

Q. Provided the lead-well was kept nearly full?

A. Even if it was not.

Q. Then you say that letting the slag congeal, you forked it off—pitched it off, and then ladled out the metal?

A. Yes, sir.

Q. When you ladled off that metal was this slag exit closed right above it?

A. Yes, sir.

Q. It had to be?

A. Not necessarily.

Q. Could you ladle out the metal and have slag running
142 down all the time?

A. You could just change the channel, so it would run to one side.

Q. And that was done, was it?

A. No; not while I was there it was not.

Q. Then, when you saw this Grant experimental Karsten furnace in operation, the slag run into and out of the forehearth, and you had to stop the slag exit, let the slag congeal, and ladle it off?

A. That was one instance.

Q. The metal was ladled out in the ordinary way. Is that the way you understand Karsten's furnace was operated many years ago?

A. I don't know anything about that, sir?

Q. You don't profess to know anything about that?

A. No, sir.

Q. Your work paid a licence fee of a thousand dollars for using these lead-wells?

A. We did.

Q. Do you think these lead-wells of Keys and Arents are quite an improvement on the old system of tapping, the old taphearth and basin?

A. From the bottom, yes.

Q. Do you think the old tap-hearth and basin is quite an improved method of withdrawing clean metal from the forehearth or forecrucible of a furnace to first letting the molten masses settle and then pitching off the slag and skimming off the matte and speiss and then ladling it out. Do you think the old taphearth you have just mentioned quite an improvement for the purpose of withdrawing molten metal from the bottom of the crucible of the fur-
143 nace over letting all the molten masses run into the forehearth.

A. Do I consider this old method of tapping from the bottom an improvement over the other matter; do I consider that the tapping of lead from the bottom of the furnace, a- described there, is an improvement over taking lead from the furnace like that; is that the understanding? I do not understand it; I will answer intelligently if I can understand.

Q. We will suppose the old system of running a furnace, if it was like the Karsten furnace in primative days, before they attached these tap hearths and basins; suppose, instead of attaching a tap hearth and basin to it, they shut of- the slag exit, pitched off the slag, as you say, and then if there was any matte or speiss skimmed it off and then ladled it out, do you think it would be an improvement to attach a tap hearth and basin to it, as in Karsten's cut, to attach a tap hearth and basin to it?

A. No.

Q. So that you differ with the generality of lead smelters; did you measure this so-called Karsten furnace being operated by Mr. Grant—this experimental furnace?

A. No; I did not.

Q. Can you give any idea as to the size and formation of the inner crucible in proportion to the outer?

A. No; I did not measure it.

Q. Do you know anything about how far this brasque par-
144 tition extended down?

A. No, sir; those matters I never take into consideration.

Q. You don't know anything about how large this eye or slag exist is?

A. The ordinary size.

Q. You say these matters you never take into consideration?

A. No, sir.

Q. Just explain the connections of the attachment as claimed by Keys and Arents.

A. They are various; Messrs. Keys and Arents and probably every other smelter have their ideas and make them accordingly.

Q. Would not the height of the tuyeres, the slant across the bottom of the crucible, the size of the slag eye, and whether it was left open, according to Karsten, have everything to do with whether the furnace would run at all or immediately freeze up and be a nuisance?

A. I doubt it very much; I can take one straight square, as it is there, and run it.

Re-examined:

Q. If you discover that you have built some of these openings too large, what would you do?

A. Close them up.

Q. Would it require any scientific metallurgy or theory of scientists in the laws of nature to know how to stop up those holes and make them smaller?

A. No, sir; anybody would know that.

145 The defendants, to further maintain the issues on their part, then called as a witness GEIST, who, being first duly sworn, testified as follows:

Q. Where do you live?

A. Pueblo.

Q. Your business or profession or occupation?

A. Smelting ores.

Q. How long have you been engaged in that business?

A. Well, about 14 years.

Q. Where have you followed this business?

A. Colorado and Utah.

Q. Are you one of the company owning the Pueblo smelting works?

A. Yes, sir.

Q. How long have those work- been in operation?

A. Since 1878.

Q. How many furnaces have you there?

A. Eleven.

Q. How many did you start up with?

A. One.

Q. Up to 1880 how many did you have?

A. Three.

Q. How did you withdraw the molten matter from the furnace?

A. We withdrew it in two ways; we withdrew it by a tap and ladling and we withdrew it by tapping it out into a lower basin and ladling it out from there.

Q. In other words, in that method as appears by that model sitting on the table?

A. Yes; that is the thing.

Q. What was the capacity of those furnaces you tap that way?

A. The same as the others.

Q. How many did you tap in that way?

A. Four; and at the same time two the other way.

146 Q. About how long a time did it take you to tap your furnaces in that way—the old way?

A. It would take about a couple of minutes.

Q. How much lead would you tap out at a time?

A. Generally in the neighborhood of a ton?

Q. Somewhere from a minute and a half to two minutes, do you say?

A. Yes, sir.

Q. Did you ever experience any difficulty in stopping that tap hole, except through awkwardness, which was very easily remedied?

A. Nothing.

Q. Did you ever have any overflow in your receiving basin?

A. Oh, yes.

Q. Ever have any burning or conflagration there?

A. No, sir.

Q. Anybody injured?

A. Not in that way.

Q. Did you ever have slag or matte to flow out?

A. Yes.

Q. Did you ever have any sows to form?

A. Lots of them, but that was before I tapped this way; that was when I was ladling out.

Q. You run at the same time two furnaces with the Keys and Arents attachment; did you find any less liability to the formation of accretions or sows in the furnace with the Keys and Arents attachment to them than in the others?

A. No, sir.

Q. Now, as a smelter do you say that the Keys and Arents attachment has no effect towards the preventing the formation of sows?

A. It has no effect whatever.

Q. How much time, in the course of 24 hours, does it really save in running a furnace over that necessary to run a furnace with the old method of tapping, assuming each furnace to be of the same capacity?

147 A. There is no time lost either way; both are alike, *both are alike.*

Q. Is any more skilled labor required in the old method of tapping than in the new?

A. Not a bit.

Q. Are you now using the Keys and Arents attachment, just as it appears on that drawing behind you?

A. No, sir.

Q. How are your Keys and Arents attachment shaped?

A. Well, they are straight channel*l*ed from the bottom of the furnace.

Q. Like as it appears here?

A. Like this tap channeled down there.

Q. You have not any slanting channels?

A. No, sir.

Q. Where does your slag escape on the upper part—on the same side?

A. No; on the other side.

Q. Do your furnaces work now with the straight channel, just as those two furnaces to which you had attached the slanting channel heretofore?

A. I never had a slanting channel.

Q. Describe how they worked after you have blown in; first tell us how you charge your furnace?

A. I take and melt lead in the bottom so as to prevent any slag from coming down in the bottom of the crucible. Then I charge regular charges, proceed in the regular method; in either case it don't make any difference whether the furnace had this side method of drawing off, or this method. After a while you take and uncover the lead-well and ladle it out from that. Then this other one; the slag shows the furnace is very nearly full of metal; might tap out some; that is the only difference between the working of the two kinds.

148 Q. What is the size of these horizontal channels that connect your lead basin or well, whatever you call it—connect this with the inside?

A. Not less than six by nine.

Q. Any difficulty in pushing the bar through if you want to loosen anything?

A. Oh, no.

Q. Now, when you say you fill out that melted lead before you blow it in, when you say you fill in the crucible with melted lead, you mean you put in bars of bullion, don't you?

A. Put in bars.

Q. You charge the furnace and blow in; I will ask you whether or not a workman can dip out, if he choses to do so, the lead from your basin, this basin?

A. He can continue to dip it if you desire until the slag comes down and rises here; I have done that lots of times; run the slag all over the place.

Q. Would it work any differently if this channel were included, as on that picture?

A. I don't think it would; the principle is the same.

Q. I have not asked you whether you studied at Clausthal or Freiburg; did you ever go through with all that folderol?

A. No. I had an education down East, but then my main education is what I have been educating myself.

Q. In the furnaces, as tapped by the old method, did you have to clean them out any oftener to relieve them [of] sows, bears, cubs, anything of that kind, than you have done with those that had the attachment called the Keys and Arents?

149 A. No, sir. There was no difference in the running; one would make as long a campaign as the other.

Cross-examined:

Q. You say when you had your lead basin located like this, and instead of passing up through a tap, as by the Keys' and Arents' method, that if you take all the lead out of this basin the slag would run right out: you say that if you had this basin located similar to this model, and the lead run through this lower eye into it, and you kept dipping, you would finally have slag running out.

A. I say we, in our furnaces, often dip the lead out, and the slag runs out through the lead-well.

Q. You say a furnace was constructed that was perfectly straight

from the bottom of the crucible of the furnace to the crucible of the lead-well.

A. It was a straight line.

Q. Do you think that the result would be the same if the basin was placed at a suitable elevation above the bottom of the furnace, so that the lead had to advance by hydrostatic pressure up into that basin; do you think the result would be the same?

A. Yes, sir; just the same.

Q. You think, do you, that if that basin was moved up here, that if you continued to dip the lead would all go out without any lead pressure on it, and the slag fill up into that basin?

A. Yes, sir.

Q. That is to say (take that cut), if that furnace is now in
150 operation, and in the interior where you see the red and blue line and the letter A, and there is about a foot of lead in it, that you can proceed to tap that out by continuing to dip out of that basin, B, and it will advance through the tap, C, and be filled by slag?

A. Certainly it would.

Q. The height of the basin would not have any effect?

A. I expect you might make a basin so high you could not dip it.

Q. You said to Col. Macon you did not go through this folderol education at Clausthal or Freiberg; that you were practically educated; have you not always had in charge of smelting furnaces men who have been educated at one or the other of those places—Clausthal or Freiberg?

A. No, sir.

Q. Have you not always had a metallurgist whose business it was to make up charges?

A. Yes.

Q. Who was educated?

A. No; not educated.

Q. Where were they educated?

A. I don't know; I was generally the man that did it.

Q. You did it; ah, you don't mean to say that you are not an educated metallurgist; did you say that?

A. I never said so.

Q. Who has been in charge of that department?

A. I was educated principally down East, in Boston and New Haven, and in — old Latin school, Sheffield, scientific school of Yale College.

Q. That is considered a very fine school to learn mining, engineering, and metallurgy?

A. Well, the theory of it, I rec-on.

Q. Don't you consider that a good school to learn?

151 A. First rate for a basis to build on.

Q. To build on; I agree with you entirely. Do you say it is not necessary for a man to study and learn metallurgy before he can take charge and operate smelting furnaces, and regulate the charges, before he is competent to mix fluxes and charge furnaces?

A. Oh, he wants to have some education; he wants to have the theoretical as well as the practical; he has got to have the practical with it.

Q. He wants the theoretical, does he?

A. He wants some.

Q. You say you tapped a ton of lead at a time by the old system?

A. Yes, sir.

Q. How large is your tap basin?

A. Oh, it will hold five or six tons.

Q. You say you often got slag out?

A. Oh, no; I say sometimes I have done it—very seldom, though.

Q. Suppose all the — runs out of the bottom of the crucible into the lead basin; into your lead tap hearth and basin, would it interfere with the smelter when the low-grade ore and fluxes came down onto the hearth?

A. Well, it might interfere a little.

Q. Is it your opinion that it would be only a distant possibility, not a strong probability?

A. It would not be there much.

Q. The furnace would run along about as well?

A. Just as well.

Q. When you first charge up a furnace, as you have stated, what do you put in the lead bath for if you can smelt just as well?

A. So as to have a little something to work, not to get the charge too low below the tuyeres.

152 Q. You say this lead-well does not prevent the formation of sows or bears?

A. Not a bit.

Q. If you keep a certain amount of lead in the bottom of the furnace does it enable you to handle easier?

A. I don't believe it makes a bit of difference—not a particle.

Q. You could remove them just as easily; that is, in your opinion? You paid $2,000 for the privilede of using the lead-well?

A. Paid Mr. Arents $2,000.

Q. You don't consider it as any advantage over the old system of tapping, do you?

A. What, paying $2,000?

Q. Well, you are very dull, or I am. You don't consider your lead-well as any advantage?

A. On certain classes of ores I consider the lead-well a detriment; but if you have a very heavy percentage of lead I consider it an assistance.

Q. Generally speaking, as a smelter, more practical than theoretical, you do not consider it an improvement on the old method, do you?

A. On the average of ores that we have had there, no, sir.

Q. Is it not?

A. No, sir; I don't use a clay plug—I use a short wooden plug.

By the COURT: Q. Do you know the distance of the tap of your lead-well from the tuyeres—the space between them?

A. Between the tap of the lead-well and the tuyeres is in the neighborhood of ten inches, sir.

Q. I understand you to say you- lead-well was horizontally located with the inner crucible of the furnace—the bottom?

A. Here is the crucible; here is another small crucible out
153 there. It has a connection between the bottom of the lead basin; it is horizontal, the — as the crucible; both are on the same level, and the tuyeres are ten inches above the top of the crucible.

Q. How far from the bottom of the furnace?

The COURT: That don't matter.

154 The defendants, to further maintain the issues on their part, then called as a witness —— JAMES, who being first duly sworn, testified as follows:

Q. Where do you reside?
A. Denver.
Q. What is your business, occupation?
A. Smelting.
Q. How long have you been engaged in that business?
A. Since January, 1880.
Q. Where were you educated?
A. At Freiberg and Clausthal.
Q. Any other place in Germany?
A. No, sir.
Q. Are you a practical smelter?
A. No, sir.
Q. You are one of the Grant Smelting Company, one of the members of the Grant Smelting Company, and have been since some time in January, 1880?
A. Yes, sir.
Q. Did you see the furnace built by Mr. Grant, after the model given by Karsten, at Leadville, in the Grant Company's Smelter?
A. Yes, sir.
A. About what was its capacity per day?
A. It was a very small furnace, possibly seven to ten tons per day, according to the charge; the furnace run on tonnage.
Q. Did you examine it so to see whether this channel was straight, horizontal, or slanting?
A. That is my business, looking round the works, general supervision; saw it planned, everything in connection with it; saw it produce metal through that lower tap-hole.
Q. Did you see where the slag escaped from the inside?

A. Yes, sir; the slag came through the upper hole there,
155 sometimes run over, the lead, or bullion, as we call it, sometimes aro-nd it, just as the men made it for their own convenience.

Q. Did you watch their operations for the purpose of determining whether this would work?
A. Yes, sir.

Q. And you saw them allow the slag to run here and turned it to one side, as they elected, did you?

A. Yes, sir.

Q. Did you notice whether it required any considerable time or exertion or ingenuity to turn the slag away from here to one side?

A. No, sir; it did not. I saw them take a little piece of sheet iron once and turn it over to one side.

Q. Did you observe the passing of slag over this lead-well in a piece of sheet iron?

A. Yes, sir.

Q. Did you see them ladle any metal out of this lead-well?

A. Yes, sir; several tons, at different times.

Q. Did you see them at any time take it off with a fork or any other instrument, the crust of the slag, throw it one side, and then ladle out the metal?

A. No, sir. I saw them dip a ladle into the metal and throw it off; they did not throw any slag off the lead.

Q. Did you see the smelter; that is, a furnace, of which this is a model, working in your establishment?

A. Yes, sir; possibly three months; may have been more than four months before the smelter burned.

Q. Tell the jury whether there was any difference in the action of this lead-well and this lead-well.

A. Not a particle, sir; they did oftener from here than they
156 did from there, if any difference, because this was a little more convenient to where the smelter stood.

Q. Did you ever notice them to put on increased blast so as to test the fact in this well?

A. It works exactly the same in every principle.

Cross-examined:

Q. You have just stated what you saw?

A. General observation; that is my business around the works; seeing that everything is running.

Q. The only difference in that would be if this got chilled you would drive an iron bar straight through?

A. There is a place left here in each and every one of them to drive it through.

Q. Those channels on the side of the furnace are just as large as the others?

A. That is not the opening I mean.

Q. You have just stated what you saw, with reference to that so-called Karsten furnace in operation; for how long a time?

A. We only put it up for experiment out of fire-brick.

Q. Did not put a water-jacket?

A. It was just as lasting as the others. Was there eight or ten times during the day and night, looking at it work; a portion of the time the slag run over it, a portion of the time it was carried over in a sheet-iron spout; and sometimes, I would say this, that the smelter there usually kept this so full of lead it was impossible to be without any slag there; there were several times from the

157 thickness of paper to a quarter of an inch.

Q. Tell us how they kept that lead-basin just so full.

A. By not dipping.

Q. When they did dip they dipped a very small quantity?

A. They would dip what we would call a pig out, which is 100 pounds or 108, when they dipped. We never run slag and dipped at the same time in any furnace that we worked.

Re-examined:

Q. On the most of your furnaces you used this slanting tap, something similar to that, only further from the bottom of the furnace; suppose this straight tap there should be clogged or stopped up, was there any difficulty in running a bar in?

A. Not through here, but from here, this channel, it is not as easily done; you can get a small bar through, possibly, this hole here, on this side, between two by four or six, generally use a half inch rod goes through there.

Q. In your smelting operations, using this Keys and Arents attachment, have you ever had slag to come up into the lead basin?

A. Yes, sir. I have seen it.

158 The defendants then read in evidence on their behalf, from the deposition of ROBERT BIEWEND, the cross-interrogatories as follows:

Cross-interrogatory first. Have you ever seen the furnaces of J. B. Grant & Co., at Leadville, Colorado, or do you know anything about them?

Answer first. No.

Cross-interrogatory second. Have you ever seen specifications of Keys & Arents' patent, or their letters patent?

Answer second. No.

Cross-interrogatory third. Have you ever seen a furnace constructed according to the drawing attached to Keys & Arents' patent, and do you know how such a furnace would act when in operation?

Answer third. As I have never seen the patent drawings I cannot answer this question.

Cross-interrogatory fourth. Have you ever seen a furnace in operation like that described in Karsten's Work on Metallurgy, vol. 3rd, pages 317 and following, and volume 5th, pages 166 and following, and plate 860, table 41, of Karsten's works.

Answer fourth. I have seen the furnaces described in Karsten's Metallurgy, vol. 3, page- 317 to 322, at work, with the exception of the "Stichtiegel" furnace (Fig-. 461 to 469) and the "Sumpf Ofen, mit verdecktem Auge" (Fig-. 473 to 475, and 479 to 481, and 482 to
159 484); these furnaces which I have not seen are no more in use.

Those furnaces shown in figure- 473 and 860, viz., the "Sumph Furnaces, mit verdecktem Auge," resembles somewhat Arents' syphon tap. They differ, however, materially in that the slag runs over the forehearth (vortiegel) in which the metal is placed.

The defendants then read in evidence on their behalf the deposition of Dr. JOHN PERCY, as follows:

Interrogatory 1. Give your name, age, place of residence, and occupation or profession, and how long have you pursued such occupation or profession? Are you the Doctor John Percy who has published a Treatise on Lead Smelting, published in London, England, 1870, and a Treatise on Gold and Silver, published in London, in the year 1880.

First. To the first interrogatory he (John Percy) saith: My name is John Percy; I am sixty-four years of age and upwards; I reside at No. 1 Gloucester Crescent, Hyde Park, London; and am a doctor of medicine of the University of Edinburgh, but I am not now practising that profession. I am now engaged in superintending the ventilation, warming, and lighting of the Houses of Parli-ment. From 1851 to 1879, I was lecturer on metallurgy at the Royal School of Mines, London, but resigned that office in December, 1879. 160 The reason for my resigning is stated in a letter at the end of my volume on Gold and Silver, published in 1880. I am the author of a Treatise on the Metallurgy of Lead, published in London, in 1870, and of a Treatise on the Metallurgy of Silver and Gold, published in London, in 1880.

Int. 2. Hereto attached, marked Exhibit A, is a copy of a specification, forming part of certain letters patent granted by the United States to Winfield S. Keyes and Albert Arents. Please to examine said specifications, and give your opinion as to the novelty or lack of novelty thereof, and your reason for such opinions.

Second. To the second interrogatory, he saith: I have read Exhibit A, and am of opinion that what Messrs. Keys and Arents claim as their invention is not novel. My reasons for that opinion are as follows:

1st. Karsten, in the 5th volume of his "System der Metallurgie," published in 1832, in Berlin (p. 166), described a furnace for the smelting of plumbiferous substances, in which the reduced lead flowed from the bottom of the furnace into an external cavity or basin, and rose therein to the same level as the lead accumulated within the surface.

In the Atlas of Plates, illustrative of Karsten's Treatise, engravings showing the construction of such a furnace are given, and of these No. 860, which is a vertical section on the median line 161 from front to back, demonstrates, in my opinion, that by suitable management exactly the same results may be obtained as with the furnace claimed as the invention of the plaintiffs. The difference between the two furnaces is in the relative dimensions of the channel of communication between the hearth and the external cavity or basin. In Karsten's furnace that channel is much wider, that is, measured horizontally from side to side, than in the plaintiff's furnace, in which it resembles a round pipe in shape. Slag, regulus, and speiss, which may be produced in smelting, would necessarily float on the molten lead within the furnace, owing to their specific gravities being much lower than that of molten lead; and my

opinion is that in Karsten's furnace such substances might by suitable management be effectually prevented from escaping into the external cavity or basin; but supposing that any or all of these substances should pass into the external cavity, they would rise to the top of the molten lead, therein accumulated, and not injure its quality; for while within the furnace they must, as previously intimated, have floated on the molten lead in the hearth, and produced their greater effect upon that lead, whatever that effect might be.

162 Int. 3. Do you know of any book or publication published in Europe, prior to the year 1871, in which this same principle claimed by the patentees in the specifications of this patent as their invention is described, or in which any similar process or method for accomplishing the same result by substantially similar means is described? If yea, give the name of such book or books or publications; state when and where the same were published, the page and volume of each book or publication at which such principle, process, or method is described, and state whether such book or publication was or was not published for sale in Europe prior to the year 1871.

Third. To the third interrogatory he saith: Such books were publicly for sale in Europe prior to the year 1871, as testified in my answer to the second interrogatory.

Int. 4. If you say that such book or books or publication were publicly for sale in Europe prior to 1871, state how long prior to that year they were so for sale.

Fourth. To the fourth interrogatory he saith: I presume that books published in Berlin, Clausthal, and this country find their way throughout Europe very soon after their publication. All that I can assert from personal knowledge, with respect to the books which I have herein referred to, is that I have possessed those books long anterior to 1871.

163 Cross-interrogatories:

1. If, in answer to direct interrogatory No. 2, you state that the device described in Exhibit A is not new, then state where such a device of such shape and for such purposes as the one *the* marked in said Exhibit A was used prior to 1871.

First. To the first cross-interrogatory he saith: I have answered this interrogatory in my reply to the second direct interrogatory.

2. If you state that said device, marked Exhibit A, is similar to any other metallurgical apparatus or device known to science, or having been in use prior to 1871, then state what such similar apparatus consisted of, and when, where, and for what particular purpose it was used; state fully.

Second. To the second cross-interrogatory he saith: I have fully answered this interrogatory in my reply to the second direct interrogatory.

3. Are you acquainted with what is called a hydraulic elevator, a hydraulic press, and a hydraulic jack? If yea, state whether or not these devices are different from each other, and whether or not all of them are based and worked on the same principle?

Third. To the third cross-interrogatory he saith: In my opinion, this question is not connected with metallurgy, and therefore decline to answer it.

4. Can any principle whatever be invented, in your opin-
164 ion? If yes, please state what is meant by the term principle. And may or may not, in your opinion, a principle be employed for various different devices, according to the different purposes which such different devices are to serve?

Fourth. To the fourth cross-interrogatory he saith: I submit that this question is not one for the consideration of a metallurgist.

5. If, in answer [to] the third direct interrogatory, you find it necessary to refer to Karsten's System der Metallurgie, vol. 5, pages 150 to 180, inclusive, and his Atlas, at table XLI, figures at page 850 to 867, inclusive, and are of the opinion that there is nothing new or different in principle in the Keys & Arents patent, as shown in Exhibit A, from the furnace described in said Karsten's work and Atlas, then please state whether or not the basin located in front of the breast of Karsten's furnace, and connected with the interior hearth of said furnace, is called a forehearth or forecrucible, and whether or not said basin serves (1) as an overflow and exit for all the slag the furnaces produces; (2) as an opening through which incrustations and accretions which may form in the canal and main, or interior, hearth are removed; (3) as a place for the accumulation of lead and lead regulus, or lead matte, in conjunction with the canal and interior hearth; (4) as a place within which the completion of
165 separation of lead regulus and slag from each other takes place; (5) as a vessel through which, like the crucible of any other furnace having no forehearth, the meta-lic products, such as metal and regulus and speiss, are tapped.

Fifth. To the fifth cross-interrogatory he saith: The answer muct be sought for in Karsten's own description; but with reference to the particular questions in this interrogatory numbered 1, 2, 3, 4, and 5, I should say that whether the results specified will occur depends on the manner in which the furnace is worked.

6. Please examine the photograph attached hereto, and marked Exhibit B. It is a photograph made from a copy made from figures 858, 859, and 860, of Karsten's Atlas to his "System der Metallurgie." Do you recognize these figures as a correct representation of said figures and said furnace in said Karsten's Atlas? Please examine also, Exhibit C, hereto annexed. It represents an ideal furnace, with the old-fashioned tap arrangement. And then state whether or not the Karsten furnace, Exhibit B, is not tapped like the furnace, Exhibit C, and whether or not both these furnaces represent an entirely different way of tapping from the mode of withdrawing lead and other metals described and represented in Exhibit A.

166 Sixth. To the sixth [cross-] interrogatory, he saith: I have examined the photograph attached to this commission, marked Exhibit B. I believe it accurately represents the figures referred to in Karsten's Atlas. With respect to an ideal furnace, represented in Exhibit C, I decline to give an opinion, because, in my capacity of metallurgist, I deal only with what is practical.

7. Please state whether or not the Karsten furnace, Exhibit B, is tapped in the old-fashioned way, as all other furnaces were tapped prior to 1871; ma-nely by a tap canal, leading downward from the bottom of the furnace hearth, and to the outside, being all the time closed with clay or other suitable material, and opened only at short intervals, from time —, in order to allow the accumulated metal-ic substances, lead, matte, and so forth, to run out from the forehearth and enterior hearth into the tap basin, located outside the furnace, and beneath the tap canal, instead of a tap as represented in Exhibit A. In other words, please state whether or not this Karsten furnace, Exhibit B, is provided with a periodical working tap arrangement, as of old, or with a Keys and Arents device, for withdrawing the molten substances.

Seventh. To the seventh cross-interrogatory he saith: After full consideration, I should say after the construction of Karsten's furnace, referred to in Exhibit B, is such that it may be worked exactly in the same manner and with the same results
167 as the furnace claimed by the plaintiffs as their invention.

8. Considering the relative long and narrow canal, or tap, C, connecting the basin B with hearth and furnace A, in Exhibit A, do you believe that any other substance would remain liquid in said canal but metals at a low temperature, such as lead and tin and zinc? In other words, do you believe or not that liquid slag or matte or speiss would remain liquid in said tap and basin?

Eighth. To the eighth cross-interrogatory he saith: Whether a molten substance would be solidified in the channel *C*, in Exhibit A, would depend on the temperature at which it left the hearth, on its conductivity for heat, on its viscosity, on the rate of its movem*a*nt, and on the temperature and conductivity for heat of the material of which the channel is formed. I have seen slag flow uninterruptedly through a long, narrow tube-like channel in sandy ground, encrusted over at the top with a thin layer of the same slag, consolidated by cooling; and the melting point of such a slag is immensely higher than that of tin, lead, or zinc.

9. Considering the fact that the only source of heat for keeping substances liquid in the basin *b*, Exhibit A, comes from the hearth *a*, and travels by the heat-conducting power of any substance in tube *c*, only from *a* to *b*, do you believe that slag, matte, and
168 speiss, if once liquid in the basin *b*, would keep liquid, or do you believe that tube and basin would be completely obstructed by these congealing substances. Please state your opinion on this subject fully.

Ninth. To the ninth cross-interrogatory he saith: As the basin "*b*" in Exhibit A, is exposed to the cooling action of the air, I do not, of course, believe that "slag, matte, and speiss, if once liquid in basin '*b*' would keep liquid," but I do believe that the tube would be completely obstructed by these substances congealing therein. I do not, however, see that their congelation in the basin would necessarily cause obstruction, if the furnace be suitably worked.

10. Do you believe, taking the relative positions and dimensions of lead-well, furnace, bottom, tube and tuyere openings into consideration in Exhibit A, that this arrangement, as it is, without any other exit for any other liquid product of this furnace, would work with like success as the Karsten furnace, Exhibit B?

Tenth. To the tenth cross-interrogatory he saith: In every slag-producing blast furnace there must obviously be provided a means of outflow of the slag; and if the molten metal be withdrawn unaccompanied by slag or "other liquid product," as it must be in the Karsten furnace when suitably worked, provision must be
169 made for the escape of any "liquid product" other than the metal itself.

11. Do you or do you not believe that if this Exhibit A were used for smelting lead ores, and the furnace were not provided with separate exit for slag, the slag, would dam up until it would reach the tuyere holes, and then run out of these tuyere holes?

Eleventh. To the eleventh cross-interrogatory: I do believe that under the conditions stated in this cross-interrogatory the slag would rise up to the tuyeres, but whether it would run out through them would depend upon circumstances well known to practical metallurgists. The effect, however, would ultimately be the stoppage of the blast, and consequently of the working of the furnace.

12. Have you ever seen a device like the one described in Keys and Arents' patent specification, Exhibit A, in practical operation; and, if so, when and where did you see it?

Twelfth. To the twelfth cross-interrogatory he saith: My personal experience in lead smelting is confined to the smelting of lead ore in reverberatory furnaces and ore hearths and the smelting of lead slags in reverberatory and blast furnaces. I have never seen the operation of smelting in such a furnace as Karsten's, previously described, and therefore not in such a furnace as is claimed by the plaintiffs as their invention.

13. Does the furnace described on page 418, 419, and 420
170 of John Percy's Metallurgy of Lead, 1870, possess any thing or any part which is like or similar to Keys' and Arents' device, Exhibit A? And, if yes, please state which and wherein the likeness consists, and wherein the difference, if any, exists.

Thirteenth. To the thirteenth cross-interrogatory he saith: I should say that the furnace described by me in my Treatise on Lead Smelting, pages 418, 419, 420, and published in 1870, does possess much that is like the furnace claimed by the plaintiffs as their invention, though it differs therefrom in not having a tube-like channel through which the molten metal ascends into a cavity or basin.

14. If you have occasion, in answer to said 3rd direct interrogatory, to examine Watts' Chemical Dictionary, published in 1868, vol. 3, pages 480, 490, 491, 495, and 496, and to refer to any furnace, or improvement or device attached to any furnace, and to compare the same with said Exhibit A, you will please point out the differences and resemblances between any such furnace, improvement, or device attached thereto and found in said Watts' Chemical Dictionary, and

the improvement set out in the patent of Keys and Arents, as shown in said Exhibit A, stating fully and in detail.

Fourteenth. To the fourteenth cross-interrogatory he saith: I have not found it necessary to consult the treatise referred to in this cross-interrogatory.

171 15. If you have occasion, in answer to said third direct interrogatory, to examine Lampadin's Handbuch der Algemeinen Huetttenkunde, published at Göttengen, in Germany, 1805, vol. 1, part 2, page 57 and following, and Schubarth's Technical Chemistry, 2nd edition, vol. 1, page 183, plate 11, figure 20, published in Berlin, Prussia, in 1835, and to refer to any furnace, or improvement or device attached to any furnace, and to compare the same with said Exhibit A, you will please point out the differences and resemblances between any such furnace, improvement, or device attached thereto and found in said works and the improvement set out in the patent of Keys and Arents, as shown in said Exhibit A, stating fully and in detail.

Fifteenth. To the fifteenth cross-interrogatory he saith: I have not had occasion to consult the works referred to in this cross-interrogatory.

(S'g'd) JOHN PERCY.

172 Defendants then read in evidence the deposition of H. BAUERMAN:

Interrogatory 1. Give your name, age, place of residence, and profession or occupation, and how long have you pursued such profession or occupation. Do you know the parties to this suit or either of them?

First. To the first interrogatory he (Hilary Bauerman) saith: My name is Hilary Bauerman; I am forty-six years of age and upwards; I reside at 41 Acre Lane, Brixton, London, England. Am a mining engineer and metallurgist, and have been in consulting practice since 1864. I am personally acquainted with Mr. J. B. Grant.

Int. 2. Were you in the United States of America at any time during the year 1881; if yea, were you during that year at Leadville, Colorado?

Second. To the second interrogatory he saith: I was at Leadville, Colorado, in the month of May, 1881.

Int. 3. If you answer the last interrogatory in the affirmative, state whether or not, upon that occasion, you say the furnaces then in use at Grant's Smelting Works, in said Leadville; and if yea, whether or not you examined said furnaces?

Third. To the third interrogatory he saith: On that occasion I did examine the furnaces in use at Grant's Smelting Works.

Int. 4. Please examine the copy hereto attached of the specifications accompanying certain letters patent granted by the United States to Winfield Scott Keys and Albert Arents, for an

173 alleged improvement in furnaces for smelting lead and other ores, and give your opinion as to the novelty or lack of novelty in said alleged invention and your reasons for such opinion.

Fourth. To the fourth interrogatory he saith: I have examined the copy referred to in this interrogatory, and do not consider the invention claimed in Keys and Arents' specification to be novel, for the following reasons:

First. The physical principle involved, namely, the hydrostatic principle of "communicating tubes," is not a new discovery.

Second. The detailed parts of the invention are not new. The extension built on one side of the furnace, with the basin and tube B and C, is substantially similar to an exterior forehearth in continuous communication with the working-hearth or crucible of the furnace, which latter arrangement has been described as in use long before the date of the specification.

Third. The method of keeping the hearth bottom covered with molten metal, which is the practical result of the arrangement, is not new. It is an essential detail of the ore hearth method of smelting which has been practiced both in England and America for many years previously to the date of the specification.

Fourth. The practice of removing the metal from the hearth continuously, which is another result of the arrangement, is not
174 new. It is to be found in the ore hearth process, and in the process followed at Bleiberg, in Carinthia.

Fifth. The method of removing the metal from the forehearth by ladling is not new. It was practiced in France by iron founders, according to published accounts, in the year 1765.

Int. 5. Do you know of any other furnace or furnaces in operation in America prior to the year 1871 in which the same principal was used or in which the same results were accomplished in substantially the same manner as that described in said specifications? If yea, state where, when, and by whom such furnaces were used and operated.

Fifth. To the fifth interrogatory he saith: The only lead furnace which I know to have been in use in America previous to the date of the specification of Keys and Arents' patent is the American ore hearth, which I saw in action in Missouri, in the spring of 1871, at Mine La Motte.

Int. 6. Do you know of any book or publication published in Europe prior to the year 1871 in which this same principle claimed by the patentees in the specifications of this patent, as their invention is described, or in which any similar process or method for accomplishing the same result by substantially similar means is described? If yea, give the name of such book or books or publications; state when and where the same were published, the
175 page and volume of each such book or publication, at which such principle, process or method is described, and state whether such book or publication was or was not publicly for sale in Europe prior to the year 1871.

Sixth. To the six- interrogatory he saith: I am of opinion that the principle claimed by the patentees is to be found in the blast furnace illustrated in Fig. 860, plate 41, of "Karsten's System der Metallurgie," and described at page 166 of volume 5 of the text, which work was published at Berlin in 1832; the method of ladling metal

from the open forehearth of a blast furnace in iron foundery is represented on Plate IX of the article entitled "Forges on Art du Fer," which is contained in the third volume of the Receuil des Planches of the Encyclopedia of Diderot and D'Alembert, published in Paris in the year 1765. The whole of the above works were publicly for sale in Europe prior to the year 1871.

Int. 7. If you say that such book or books or publication were publicly for sale in Europe prior to 1871, state how long prior to that year they were so for sale.

Seventh. To the seventh interrogatory he saith: "Karsten's System der Metallurgie" was for sale in Germany in the year 1854, at a considerable reduction upon the original price of publication.

And I obtained the article, Forges on Art du Fer, from the
176 Encyclopedie in 1869. Presumably, therefore, these works were on sale from their respective dates of publication downwards.

Cross-interrogatories:

1. If, in answer to direct interrogatories Nos. 2 and 3, you state that your were in Leadville and did see Grant's Smelting Works in 1881, then please state by what method the lead is withdrawn from the furnaces in Grant's Smelting Works, and whether or not the lead is withdrawn from said furnaces by means of the identical method described in the specifications of Keys and Arents' United States patent, 1871, and annexed hereto, Exhibit A.

First. To the first cross-interrogatory he saith: The lead is drawn from the furnaces in Grant's Smelting Works through a passage moulded in the substance of an addition to the furnace representing the forehearth, and not through a tube of iron, clay, or other material like that marked C in the specification of Keys and Arents' patent.

2. If, in answer to direct interrogatory No. 4, you state that Keys and Arents' improvement in furnaces, as described in their patent in Exhibit A, hereto annexed, is not new, then please state when and where you first saw any such apparatus like Keys and Arents' improvement, what it consisted of, and what purpose it served. State fully and in detail. And state also particularly whether
177 any such apparatus you ever saw, if any, like Keys and Arents' improvement was different in some respects from Keys and Arents' improvement as described in Exhibit A, and, if so, in what respects.

Second. To the second cross-interrogatory, he saith: I do not remember having seen an arrangement of the kind in question used in Europe, I should consider it unsuited to the ordinary class of lead ore smelted in England.

3. If in answer to the 5th direct interrogatory, you state you saw no other furnace or furnaces in operation in America, prior to the year 1871, in which the same principle was used, or in which the same results were accomplished in substantially the same manner as that described in said specifications of Keys and Arents' patent, you will point out the differences and resemblances in detail, be-

tween said furnace or furnaces so in operation, and the said improvement of Keys and Arents.

Third. To the third cross-interrogatory, he saith: The American ore hearth, as used in Missouri, is the only furnace with which I am personally familjar. I saw it in the spring of 1871, before the date of the plaintiffs' patent, and at that time the ores now smelted at Leadville were unknown.

4. If, in answer to direct interrogatory No. 6, you have occasion to refer to Karsten's System der Metallurgie, vol. 5, pages 150 to 180, inclusive, and his Atlas, table 41, figures at 850 to 867, inclu-
178 sive, and state that the furnace described in said work is similar in principle to the improvement of Keys and Arents, as described in exhibit A, then state whether the lead from the crucible in said work is discharged in the same manner as by Keys and Arents' improvement; also state whether or not all the lead and regulus of the furnace in said work is tapped from the crucible of the furnace by means of the common, old-fashioned tap canal and basin, as represented in the ideal furnace marked Exhibit B, hereto annexed. If not, then state the difference in the methods of withdrawing the molten metals produced from the furnace referred to in said work, and the one marked and sketched Exhibit B.

Fourth. To the fourth cross-interrogatory, he saith: The method of discharging the lead from the furnaces, figured as 850, 854, and 860, on plate 41 of Karsten's work appears to be similar in principle to that claimed as Keys and Arents' improvement, namely, through a cavity at the hearth bottom into a receiving basin, exterior to the furnace stack. In these figures, the lead and regulus is not tapped from the crucible or working hearth of the furnace, but from the exterior basin, and the discharge is therefore essent-ally different from that of the ideal furnace, Exhibit C, which does not represent any construction with which I am familiar; it would be as
179 easy to ladle out the contents of the exterior basin, as to tap them; but this in no way affects the method of discharging the contents from the furnace.

5. If you have occasion, in answer to said 3rd direct interrogatory, to examine Watts' Chemical Dictionary, published in 1868, vol. 3, pages 480, 490, 491, 495, and 496, and to refer to any furnace, or improvement, or device attached to any furnace, and to compare the same with said Exhibit A, you will please point out the differences and resemblances between any such furnace, improvement, or device attached thereto and found in said Watts' Chemical Dictionary, and the improvement set out in the patent of Keys and Arents, as shown in said Exhibit A, stating fully and in detail.

Fifth. To the fifth cross-interrogatory, he saith: The furnaces referred to in Watts' Dictionary of Chemistry does not appear to me to have any particular bearing on the question.

6. If you have occasion, in answer to said 3rd direct interrogatory, to examine Lampadius Handuch der Algemeinen Hutten Kunde, published in Göttengen, in Germany, 1805, vol. I, part 2, page 57, and following, and Schubarth's Technical Chemistry, 2d—, vol. 1, page 183, plate 11, figure 20, published in Berlin, Prussia, in 1835,

and to refer to any furnace, or improvement, or device attached to any furnace, and to compare the same with said Exhibit A, you will please point out the differences and resemblances between any such furnace, improvement, or device attached thereto and found in said works, and the improvement set out in the patent of Keys and Arents, as shown in said Exhibit A, stating fully and in detail.

Sixth. To the sixth cross-interrogatory, he saith: I have not had the opportunity of referring to Lampadius's work. I have seen the figures in Schubarth's work referred to, but they are mere reproductions from Karsten, and are not described at length, so that there is nothing to be gained by discussing them.

(Signed) H. BAUERMAN.

180 The defendants then read in evidence the deposition of John M. Ordway, as follows:

Int. 1. What is your name, age, place of residence, and occupation, and do you know the parties to this suit, or either of them?

Ans. 1. My name is John M. Ordway; I am fifty-eight years old; I reside in Boston, Suffolk County, Massachusetts; I am a chemist by profession, and I have been for a large part of my life engaged in chemical manufactures, but for the last six years I have been occupied chiefly with teaching. Of the parties to this suit I know only James Grant, with whom I am personally acquainted.

Int. 2. What professorship do you hold in the Massachusetts Institute of Technology.

Ans. 2. I hold the professorship of metallurgy and industrial chemistry, to which I was appointed in 1869.

Int. 3. State whether or not, from your employment and occupation, you have skill and experience in the art or science of lead and iron smelting and a knowledge of the furnaces used in the reduction of metals.

Ans. 3. I have had some practical experience in smelting lead, and have planned and built several furnaces for such work. I have visited and observed many furnaces used for smelting lead, iron, copper, antimony, and zinc, and have studied their construction and arrangement. It has also been necessary for me to procure and study the standard books in English, German, French, and Latin on the subject of metallurgy and on the construction of furnaces.

181 Int. 8. Have you, or not, seen and known other furnaces for reducing lead or other metals, having the same principle of withdrawing the melted metal from the bottom of the furnace by a tube opening from the bottom? If so, describe them, and when and where they have been used?

Ans. 8. I have seen and known many iron furnaces which had a forebay continuous with the inner crucible, but I have never myself seen a furnace in which the forebay was separated from the inner crucible by a partition perforated at bottom. I know of such furnaces only from many books on metallurgy, from "Georgii Agricolae de Re Metallica, Liber XII, Basilea 1657," down to works of recent date.

Int. 9. Do you understand, read, and write the German language?

Ans. 9. I understand and read the German language, but rarely have occasion to write German.

Int. 10. Have you seen and known the following publications or books, said to have been printed and sold either in foreign countries, or printed in foreign countries and sold at bookstores for the sale of books of their character, viz: John Percy's Treatise on the Metallurgy of Lead, one volume, published in London, England, by John Murray, in 1870, or prior thereto.

John Percy's Treatise on Gold and Silver, one volume, published by John Murray, in London, England, in 1880.

Watts' Chemical Dictionary, vol. 3, edition of 1868, published in London.

182 How many volumes of said dictionary were published prior to the year 1870?

Karsten's System of Metallurgy, in 15 volumes, with an Atlas, published in Berlin, Prussia, in 1832; Lampadius's Handbook of Common Metallurgy, in 2 volumes, published at Göttengen, Germany, in 1805; Schubarth's Technical Chemistry, one volume, publisher in Berlin, Prussia, in 1835? If you say you have seen and know such books, state whether, or not, you know they were on sale in bookstores in the United States, or foreign countries, prior to the year 1870; and state whether, or not, you have purchased them of booksellers, and of whom; whether for your own use or for the School of Technicology, of which you are a professor, prior to 1870, except Percy on Silver and Gold, which may have been published after that?

Ans. 10. The books mentioned in the interrogatory have all been published in foreign countries, and have been on sale in European bookstores, as I have learned from the catalogues of European booksellers.

These books are still advertised as for sale.

The English books mentioned have been, and are still, for sale in book stores in this country. Such books are received here almost as soon as published in England.

I have the "Metallurgy of Lead, by John Percy, London, 1870," in one volume, 8 vo., which I bought for my own use, in October, 1871, from B. Westerman & Co., of New York.

183 I have "Metallurgy," by John Percy; "Silver and Gold, Part II, London, 1880," which I bought of B. Westerman & Co., in March, 1880.

We have deposited in the working library of the Massachusetts Institute of Technicology "A Dictionary of Chemistry, by Henry Watts, London, 1868–9, in 5 volumes, 8vo. This work belongs to one of my associates.

I believe the five volumes were all published before 1870. I have "System der Metallurgie," von Dr. C. J. B. Karsten, Berlin 1831–2," in 5 volumes, 8vo., which I bought for my own use in 1871 or 2, from Schoenhof and Moeller, booksellers in Boston.

I have "Handbuch der Algemeinen Hüttenkunde von W. A. Lampadius, Göttengen, 1804–10," 2nd part, four volumes, 12mo.,

which I bought for my own use in 1871 from Shoenhof and Moeller, of Boston.

I have "Elemente der Technische Chemie, von Ernst Ludwig Schubarth 2te, Auflage, Berlin, 1835," in 3 volumes, 12mo, which I bought for my own use in 1874, from Schoenhof and Moeller, of Boston.

I did not purchase any of these books prior to 1870, but I know that with the exception of Percy's late volumes they were all offered for sale by booksellers before 1870.

184 The furnaces thus figured by Karsten are planned for withdrawing the reduced metal continuously and as fast as possible from the oxidizing action of the blast and the intensely heated part of the slag. So the metal is made to flow constantly outward and upward through an open eye into the forehearth, which is made as high as the inner crucible; and generally the clean molten metal alone is passing through this bottom eye. When much slag is formed it is run of- separately by another eye, placed higher up, when very little slag is produced it accumulates for a long time on the top of the molten metal in the inner crucible, and the clear metal in the forebay may be partially removed many times without allowing any of the slag to escape through the eye. Then at the end of the smelting shift, the whole remaining contents of the crucible and the supernatent slag may be tapped off. In the ordinary forebay furnaces, such as are used for iron, and sometimes for copper, the inner crucible and the forebay communicate by a large free opening, extending very nearly up the whole height of the crucible, so that metal and slag necessarily come out together into the forehearth. But in theses lead furnaces described by Karsten there are two balancing columes of metal connected only by a small channel at bottom, and so long as the eye is covered by melted metal, melted metal alone can flow out through the channel into the forebay.

185 Karsten specified that in some cases the metal is withdrawn from the forebay by tapping, and in some cases it is ladled out. Neither the drawing nor the specification of Keys and Arents indicates any method of drawing off the slag; there is simply shown a chance for two balancing columns of lead, and we are told that the lead may be dipped out of the forehearth.

Neither in the balancing columns of lead, nor in the dipping out, [are] there any new principle brought out which is not indicated by Karsten; and any one skilled in the art [of] lead smelting, would readily deduce from Karsten's, a furnace possessing all the possible advantages of that purporting to be the invention of Keys and Arents.

The drawing of Keys and Arents' furnace shows a large and cylindrical crucible, and an upward slant of the channel. But the action is the same, whatever be the shape or size of the crucible, or the length or direction of the channel, as long as the eye itself is at the bottom.

Cross-interrogatory 1. What kind of experience have you had in the smelting of lead ores, and where, and how long?

Ans.1. I smelted lead sulphate, galena, and lead dross in reve-bera-

tory furnaces, at the works of the Roxbury Color and Chemical Company, in Roxbury, Mass., (now Boston) in the years 1848, 1849, 1855, and 1856.

186 Cross-int. 2. Will you state the different methods known to you for withdrawing the molten lead from furnaces in use before the year 1871, and if you know of any that have any similarity to the patent annexed hereto, and marked "Exhibit A," will you state in what particular points they are alike, and in what they differ?

Ans. 2. By my own personal practice and observation, I know of the method of periodical tapping off the clean lead through the tap-hole, and raking out the slag at another opening; also the method of allowing the lead to run off constantly by a channel in the iron apron of the so-called "American Lead Furnace." I know of other methods chiefly by report, and by the drawings and descriptions given in the standard books on metallurgy.

In the ore smelting, the stimes smelting, the litharge reduction, and the lead column furnace described in answer to the direct interrogatories, the mode of withdrawing the molten lead into the forebay by means of a covered eye at bottom, is the same as in the furnance of Exhibit A. In the subsequent disposal of the metal, they partly differ, as the former furnaces are mostly provided with a tap-hole in the forehearth, so that the clean lead may at times be partly or wholly run out into a supplementary basin; and so that in blowing out the furnace, the contents of the crucible and forebay can be entirely drawn off. Exhibit A is defective, as no provision is made in the furnace therein shown for emptying the furnace when repairs are to be made.

187 Cross-int. 4. Are you personally acquainted with any methods of extracting the molten lead from shaft furnaces prior to to 1871, other than by periodical tapping?

Ans. 4. I had no personal acquaintance with shaf- furnaces for smelfing lead prior to 1871. I saw the American lead furnaces in operation in 1851, and the discharge from them was continuous; but they are not shaft furnaces. My own work in smelting lead, copper, and antimony was done in reve-beratory furnaces, in which the tapping was necessarily periodical.

188 Defendants then read the deposition of ROBERT H. RICHARDS, as follows, to wit:

Interrogatory first. What is your name, age, place of residence, and occupation, and do you know the parties to this suit or either of them?

Answer. Name, Robert H. Richards; age, 37 years; place of residence, Boston, Massachusetts; occupation, professor of mining at the Massachusetts Institute of Technology; of the parties to this suit, I know James Grant and also, slightly, James B. Grant.

Int. 2. What professorship do you hold in the Massachusetts Institute of Technology?

Ans. I am professor of mining.

Int. 3. State whether or not, from your employment and occupa-

tion, you have skill and experience in the art and science of lead smelting and iron smelting, and a knowledge of furnaces used in the reduction of metals.

Ans. I have some skill and experience in the art and science of lead and iron smelting, and I have some knowledge of the furnaces used in the reduction of metals.

Int. sixth. If the form of the tube connecting the bottom of the furnace with the receiving basin is different, state whether or not its action is different or the same.

Ans. It would seem to me that its action must be very much the same; the difference in form would not, in my judgment, affect the principle on which this mode of withdrawing metal
189 from a furnace depends.

Int. seventh. To call your attention more particularly to the object of inquiry, suppose the connecting tube from the bottom of the furnace comes out at an acute angle, as in Keys' and Arents' plan, and at a right angle, (as in the argenta furnace), would the difference in angle make any difference in the effect produced?

[Ans.] I should judge that it would no difference at all that would effect the withdrawing of the lead from the furnace.

Int. eight. Have you, or not, seen and known other furnaces for reducing lead or other metals, having the same principle of withdrawing the melted metal from the bottom of the furnace by a tube or opening from the bottom; if so, describe them, and when and where they have been used.

Ans. In Utah, at Bingham Cañon, in the summer of 1872, I saw furnaces having this mode of withdrawing the metal attached to this; also, about the same time, I saw furnaces at Sandy, not far from Salt Lake City.

Int. 9. Do you understand, read, and write the German language?

Ans. I read German with some difficulty.

Int. 10. Have you seen and known the following publications or books, said to have printed and sold either in foreign countries, or printed in foreign countries and sold at book stores for the sale of books of their character:

190 John Percy's Treatise on the Metallurgy of Lead, one volume, published in London, England, by John Murray, in 1870, or prior thereto.

John Percy's Treatise on Silver and Gold, 1 volume, published by John Murray, in London, England, in 1880.

Watts' Chemical Dictionary, vol. 3, edition of 1863, published in London; how many volumes of said dictionary prior to the year 1870.

Karsten's System der Metallurgie, in five volumes, with an atlas, published in Berlin, Prussia, in 1832.

Lampadius Handbuch of Common Chemistry, in two volumes, published at Göttengen, in Germany, in 1805.

Schubarth's Technical Chemistry, 1 volume, published in Berlin, Prussia, in 1835.

If you say you have seen and known such books, state whether, or not, you know they are on sale in bookstores in the United States

or foreign countries, prior to the year 1870, and state whether, or not, you have purchased them of booksellers, and bought them for your own use, and for the School of Technicology, of which you are a professor, prior to 1870, except Percy on Silver and Gold, which may have been published after that?

Ans. I know Percy's Treatise on the Metallurgy of Lead, Percy's Treatise on Silver and Gold, Watts' Chemical Dictionary, volume 3, edition of 1868; five volumes were published of Watts' Dictionary prior to 1870. I also know Karsten's System der Metallurgie.

191 I do not know Lampadius's Handbuch of Common Chemistry, nor do I know Schubarth's Technical Chemistry.

Percy's Lead was for sale in bookstores in 1870. The other books that I have stated I know were for sale in bookstores prior to 1870, except Percy's Silver and Gold, which was published later.

I purchased Percy's Lead, also Watts' Dictionary, all for myself, either during or prior to 1870; I also purchased Watts' Dictionary for the Institute of Technicology about the same time. Percy's Silver and Gold I purchased later.

Int. 11. Do you know or can you state any other matter or thing which may be of benefit or advantage to the parties to this suit, or either of them, or that may be material to the subject of this examination, or the matters in question in this cause? If yes, state the same fully and at large in your answer.

Ans. I do not know any other matter that would be of advantage to the parties in this case.

Cross-interrogatory first. What kind of experience have you had in the smelting of lead ores, and where and how long?

Ans. I have had charge of the mining and metallurgical laboratories at the Massachusetts Institute of Technicology for ten years, and have smelted lead from a great variety of ores during that time, and with the furnace arranged in a great variety of ways, as

192 with forehearth, settling kettles, buggies, &c. I have visited works for the smelting of lead ores in Colorado, Utah, Scotland, Wales, England, and Saxony.

Cross-int. second Will you state the different methods known to you of withdrawing the lead from furnaces in use before the year 1871, and if you know of any that have any similarity to the patent annexed hereto, and marked Exhibit A, will you state in what particular points they are alike, and in what they differ?

Ans. My experience does not extend back of 1871.

Cross-interrogatory fifth. In those furnaces with which you were acquainted, previous to 1871, did the liquid metal in leaving the inside or crucible of the furnace pass up or down in its outward course, and did it flow continuously, and as it flowed into some receptacle outside of the furnace, did it enter over the rim of this receptacle or through a passage in its side or in its bottom?

Ans. My personal experience does not extend back of 1871.

(Signed) ROBERT H. RICHARDS.

Which was all the evidence offered by said defendants, and thereupon the defendants rested their case.

In rebuttal the plaintiffs called ALBERT ARENTS, who had been duly sworn, and who testified as follows:

Q. Are you famil-ar with the portions of Karsten's works, volume three and volume five, read by Mr. Grant here to-day and introduced in evidence?

A. I am.

Q. Are you famil*l*iar with plate XLI, figure 860, testified to here to-day by Governor Grant as being a furnace with an outer and inner sump, similar to this model, like this model?

A. Yes, sir.

Q. Have you made a model of the furnace represented by plate 41, figure 860, and other figures representing the different portions of the same furnace described in that plate?

A. I have.

Q. Is it complete and like that?

A. It is made just like that; I superintended it myself.

Q. Is it made from the scale and relative proportions, and the same proportions as exhibited upon that plate?

A. Yes, sir.

Q. Do you find upon that plate the scale of the drawings?

A. Yes, sir.

Q. Is this that model of yours?

A. That is it.

Q. Explain to the jury why that model is an exact representation of the furnace described by Karsten in this plate 41, figure 860, and the other figures the other portions of the furnace?

194 A. Well, every detail that is on this furnace, as far as it is in controversy, we have here. All that is lacking is the upper part of the shaft. This model is made *is made* on the scale of one inch to the foot. Here the two side walls of immense masonry; here the back walls. The front wall is made very thin, of bricks set on edge. The furnace is here, eighteen inches wide; this is an inch and a half; it is made on a scale of one inch to the foot; the furnace itself, of which this is a model, would be 18 inches.

Q. How far would it be the other way, the long way?

A. It would be four feet and a half, which means four feet and a half.

Q. State how the metal is withdrawn from that furnace.

A. The plate shows a tap there and a tap-hearth. I assume it was to be tapped. This forehearth is the common forehearth, into which all the molten substances which the furnace forms flow.

Q. Do you find upon that plate—you say you made this model exactly in accordance with the old tap-basin and hearth, similar to the one you have put in this model?

A. Yes, sir.

Q. Point it out to the jury?

A. Here is the ground plan, which looks like it, if you look down upon this model.

Q. That is the horizontal plan?

A. Yes, sir.

Q. Point out where you find this tap hearth and basin?

A. Here is figure 858; it represents the horizontal ground plan. 859 is an elevation. If you look against it from this way the walls go straight down, and there is a hole right over that forehearth.

Q. Show the jury why that furnace, that model of that furnace, is exactly in accordance with the figures on this plate, with reference to the mode in which the metal is withdrawn from that furnace? 195

A. Here is the tap-basin shown, here is the tap canal extending clear down to the bottom of this forehearth. It goes clear through; it was tapped in the manner Mr. Keys showed here yesterday by the model.

Q. Wasn't it tapped in the same manner as this furnace at Eureka was, before you invented the lead-well?

A. Exactly the same.

Q. As you have shown here in your direct testimony?

A. Yes, sir.

Q. Is there any difference between the tap-hearth and tap-basin, as has been admitted by both sides to be in use on all furnaces in Europe and America before your invention?

A. There is no difference whatever; this is the same.

Q. What was the office of the forehearth, which by these changes, the defendants have attempted to turn into a lead-well, what was the office in smelting, in all the smelting furnaces.

A. The offices of the forehearth were always to serve as an outside vessel, from which it was easy to tap the metal from the bottom; it was a kind of receiving basin into which all molten masses were received before they took flight, you might say, to the outside world. If that breast were entirely open, the blast would rush out, you could not smelt with it, it would be disagreeable; for that reason the lower portion of the front walls is sunk down between these two compartments, you might say, into the hearth, which extends so that the wall sticks down into the molten masses to a certain extent, the lead column and the slag stand on either side of it; of course the connecting hole has been larger and smaller. 196

Q. What is the character of that portion of the partition that extends down between the inner and outer portion of that sump furnace.

Answ. It was made of brasque, which is a mixture of about two-thirds charcoal dust by measure, and about one-third to one-fourth of fire-clay—that crumbles very easily.

Q. In practical smelting, how long would that partition last?

A. On a furnace with the hidden eye operated, in Clausthal, in the Hartz mountains, it lasted twelve hours. Every twelve hours the furnace was blown down on that account.

Q. Was it, or not, one of the objects of this Karsten furnace, this partition put in of a temporary character that it might be cleaned out?

A. Certainly; at the same time.

Q. Does it, or not, radically differ from your lead-well, in the fact that it has a temporary partition, dividing the sump furnace into two parts, whereas in your lead-well, the basin is situated on the outside, and through one of the main walls of the furnace, and has no partition.

A. Yes, sir; there is a great differonse, the fact being, with this basin, attached to the front, the front has always to be thin.
197 For that reason, this front is very distructible. If you locate a basin there, to the side of the furnace through solid masonry, then that is stationary, of substantial character.

Q. Is not a marked difference between your lead-well and this outer sump, so to speak, connected by this channel and separated by a temporary partition; that your basin is not located below, but is located, as your specifications say, at a suitable elevation, to prevent all the molten metal flowing in?

A. Yes, sir; it is located much higher, so that at no time, no matter how much slag collects, will it overflow; that is a marked distinction.

Q. Is that one of the marked improvements that you have attempted to bring about by your lead-well, that you are always bound to keep a large amount of molten metal in the bottom of your furnace?

A. Certainly; the valuable result is getting the clean lead and keeping it so in that basin; therefore it is located high, so nothing else can get in; meanwhile this is located low.

Q. Explain to the jury, as concisely as you can, why it would be practically impossible to operate a furnace built like the model from cut 860, and keep the speiss out from that forehearth, even by making that modification Mr. Grant did?

A. The description of Karsten may be considered literally, or considered from a technical standpoint; if you take it literally, having everything as he says, that furnace would not work at all; it would be a monstrosity. Mr. Grant admitted that if you
198 close the upper eye, and you tap it, get out a certain quantity, then as soon as you close the upper eye, the pressure of the blast exercises an influence upon the liquids developed in the hearth—we blow, generally, with the pressure of about one inch of mercury; lead is lighter, is driven higher up, therefore we can put about an inch and a half of lead to balance an inch of mercury. I can better illustrate this here by these several cuts on a large scale. The partition occurring in this furnace (figure 860) is this partition right here (points to diagram) between this so-called upper eye; from the bottom of it, down to the roof of the lower eye, is seven inches and a half. Karsten gives that as a working furnace. It is a fact, that when drawings are given for a working furnace, we have to take the measurement just as it is; therefore, that si seven inches and a half. Another fact, a slag-spout, on such a simple thing, is usually not depicted; the lead being tapped from the side, the slag would run out from this side of the forehearth. The slag-spout is, in Leadville, about three inches deep. This furnace don't run quite as much slag, but its slag-spout should be at least 2½ inches

deep. There remains, then, five inches; an inch to an inch and a half for pressure leaves four inches to provide for.

To balance a column of lead of four inches it has to be
199 overcome by the weight of a 12-13 inches column of slag in the interior of the furnace, that is, in order to do away with the lead and allow the slag to pass out. I have drawn here (on diagram) with blue lines the slag. I have drawn here with red pencil what would be the lead. In case this open eye is shut up (you see here is the eye) the slag, when it would only be a very little above it, perhaps a few inches, would balance the lead. The intention of this furnace was after all not to have clean lead pass through here, through the hidden eye, but to smelt and prevent the blast from passing out of the breast. This hidden eye was, prior to Karsten, placed as a tap where Karsten's open eye is now, the bottom of the furnace being formerly higher up. In this shape the furnace was blowing frequently. For this reason the furnace bottom was made deeper and the former eye, or tap, changed into a hidden eye, through which no more blast could escape, but through which still all the molten furnace products run. But even if clean metal were running it would run everything else produced by the furnace on top, producing in either case the same state of affairs you have inside of the furnace which you wanted to change, producing the same state of affairs you have in a forehearth with open breast.

Q. You are familiar with the scale of this furnace you have described, the model built from this has been testified to as being
200 built according to the scale, state how near it is like it, and whether a furnace so constructed would be at all like the Karsten furnace represented in 860, and the other figures, plate 41?

A. Of course, not knowing what the scale is, would have to make it approximately. This interior hearth, tuyeres, and bottom is very much like 860; what is lacking is simply the heavy masonry. Of course the tap hearth and tap canal are also left out; when that tap hearth and tap canal is left out, it is no furnace at all, so far as having any aparatus attached to it to withdraw the clean molten metal from it. That furnace, as it is depicted here in Karsten, you cannot get any clean metal from at all; if you clean the tap hole out you can ladle metal out of the forehearth, as a matter of course, but you will have the same results (and that is a very common-sense proposition, no science about it) as having oil and water in a tumbler and taking the water with a spoon from beneath the oil. You can do it, but every spoonful of water will be covered, of course, with oil, and every ladleful of lead will be covered with slag. If you have to ladle from the forehearth the open eye cannot be worked, in my opinion; it has to be shut on account of blowing out.

WITNESS: If you take the Karsten furnace, then you have to keep strictly to those measurements, Mr. Grant testified to it; but with an
201 open eye of three inches it cannot work; you can decrease its size, but you might just as well increase the hidden eye to suit your purpose, and make a sump furnace out of it with an open breast.

Q. I believe you have stated that to take that furnace, take the metal tap away from it, and alter it to operate it, as Mr. Grant says he has, by changing the slag eye to another position, that he would get clean metal into that forehearth, and nothing else would pass into the hidden eye.

Answer. If this was shut up, why, of course, it will pass through, because the slag has dam-ed up to a certain extent; you have got something—a few inches above the slag eye already; as I have demonstrated, it will force all the lead out into this lead bason; but for that same reason it will force everything out. The great reason of that is, because this lead basin is not placed at a suitable higher elevation than the bottom of the furnace. If you take that lead basin—if you heighten that proportionally, of course, then it will be complete. If you heighten this proportionately, move it out, and make this a heavy wall of masonry, so it becomes substantial.

Q. Would not wear out?

A. Yes. Put the slag eye here to one side and you have a furnace like ours, because then you combine an ordinary furnace with a basin on the side in a substantial manner.

Q. There has been a great deal said about this principle of communicating vessels, so separated with an opening between that the liquid can run from on- to another?

A. Yes.

Q. But the difference between the mode of operation in this Karsten model and your lead-well depicted there is, that here
202 the molten lead ascends from the crucible upwards on the principle of a water fountain, and in this case it runs on a grade directly through, directly between what was a temporary partition?

A. It is the same as in the case of an open sump furnace. I wish we were allowed to read the works by Lampadius. Prof. Karsten says the same thing I say now, and Kerl—Kerl says the same thing.

Objected to by defendants.

PL'FFS' COUNSEL: They are standard works on metallurgy; you have pleaded them besides; you have them in your pleadings.

Q. The deposition has been read here of Prof. Percy, in which he undertakes to say that this thing is not an improvement, etc. Read this paragraph to see what Prof. Percy says. Read that from there?

Objected that Prof. Percy was not cross-examined upon this.

Plaintiffs propose to show that Prof. Percy says, in a work of his, that plaintiffs' invention was an improvement.

Objection sustained by the court.

Q. Now, it has been said that all the change you have to make to turn this Karsten foresump or forehearth into a lead-well is to move your slag eye so far to the right here that the slag will not
203 run into this forehearth, is not that forehearth of such a width, in front of the inner hearth, that there is no room to

put a slag tap in front of the furnace without carrying the slag into one side at least of that forehearth, state whether that is practical on that plan in your mind.

A. The opening of this furnace below here in the level of the open eye is fifteen inches and the width of this forehearth is twelve inches; that leaves an inch and a half on either side, and you may put it through the corner, if you choose. I think by doing that the hole would be already too long for slag to pass through. Moreover, that would be more like playing. If I were the smelter I would leave the slag hole where it is and move the forehearth. But even if you move your slag eye that furnace work work. Leave the tap the same height and you have the same results I have described here. Everything in that interior hearth would pass through the hidden eye. Moreover, Karsten testifies to that himself, as demonstrated by Mr. Grant. He say- a furnace producing much slag is provided with an open eye and with a hidden eye; another furnace, which produces only a little slag, has no upper eye at all, the little slag in the latter case outbalances that lead in the forehearth; and I mean to say that if a little slag is heavy enough to pass itself through, a great deal certainly is, on the principal that if a pound turns the scale, ten pounds certainly will. Therefore, I say, you never need an open eye; the furnace will work right along without it.

204 Q. If you should succeed in getting, tapping, the slag from here, if you succeed in doing that, nevertheless would speiss, matte, and slag get into that forehearth?

A. Certainly, if you make a slag tap out of that. Let the slag accumulate a little so that you can tap it.

Q. How would it be more particularly with reference to matte, called regulus—matte and speiss?

A. Matte and speiss are about half as heavy only as lead; four inches of lead would take only eight inches of speiss to balance it, and that would not come up to the open eye, as Karsten has depicted it. If only a little slag and speiss and matte works its way from this inner to this outer sump, there being clean metal in it to start with, it covers it, and, of course, any molten material, that is not lead, getting in there destroys the useful result of a lead-well; so you see it is impossible to operate that furnace without any slag getting in the forehearth. That is my opinion. If you want to tap it at all you have to accumulate some slag above the open eye, and that slag will let the speiss and matte at least pass right into the forehearth.

Q. Is it a material thing in the art of smelting, and when you wrote your specifications and said that your lead-well was to be attached to a furnace of ordinary construction, did you not state that that furnace, of course, was intended that it must be located away from the slag eye?

205 To which question the defendants objected, that the construction of the patent is for the court and not for the witness; and the court sustained the objection. To which ruling of the court in sustaining said objection the plaintiff-, by their counsel, then and there excepted.

Q. Is or not the changing of the slag eye from the center of the front wall of a furnace a very material change in the art of smelting as applicable to the operation of a furnace?

A. It is; it is never done if you work with a slag eye or slag tap; that is always in the center of the front wall.

Q. Do you find in all the works of Karsten, Kerl, or Lampadius (who commenced in 1805), Karsten in 1832, and Kerl in 1853; they are supposed to have the whole history of smelting in Germany. Is there anything in any of those books that intimates it is allowable to put a slag tap anywhere but in the center of the furnace?

To which question defendants objected, because incompetent; and the court sustained the objection.

To which ruling of the court in sustaining said objection plaintiffs, by their counsel, then and there excepted.

Q. Does Karsten give you any written description of figure 860?

A. He gives a written description of the furnace, so far as the shaft is concerned, of this upper portion—not of this lower portion.

Mr. Grant, and all the depositions that have been read by
206 these gentlemen, say so, but they are mistaken. This lower portion is not described at all by Karsten.

Q. Refer to Karsten now, and read all the description that he gives in reference to the furnace on plate 41, figure 860, and the other figures containing the whole furnace.

A. He says of this furnace here—Mr. Grant, I suppose, by not looking close, omitted something—it is pretty near the same: "The construction of this furnace is seen by figure 858 in a horizontal section, figure 860 in a vertical section, through the forewall and back, and figure 859 in a front elevation."

And now comes that which was omitted:

"The manner of closing of this furnace is such as is applied to the so-called high furnaces for smelting; the constructions on page 163, in an article speaking of some smelting works where various furnaces, including this furnace, are described; he says the arrangement of the high furnace is seen in figures 855, 856, 857. On this page, page 164, going on, he says: "The manner of closing this furnace, or the hearth arrangement, is that of a sump furnace with open breast and tap hearth;" so that this furnace, Fig-. 858, 859, 860, is correct only, according to Karsten's description, down to the hearth arrangement; that is not used in that arrangement. Here it is shown, in Fig. 855 to 857, to be open-breasted sump furnace, forehearth and inner sump

being all one vessel, without any partition. They have used,
207 however, this sump furnace, Fig. 860, in the same work at Clausthal, where the other furnaces are, but without that eye, and for revifying litharge only, that is all. I have worked on that furnace without that eye myself. This particular furnace, where matte, etc., is smelted, has not that arrangement at all; so that Karsten has not described it (Fig. 860).

Q. In that part of Karsten's work I called Mr. Grant's attention to to-day about ladling, did it or not refer alone to iron furnaces?

A. Mr. Grant referred to volume 3, page 320, speaking of this figure 473. This is an exact model again of the same thing, heavy walls, very thin forewall, very large hidden eye; he says of that is it not provided with a taphearth. The reguline metal; that is, the metal in its metal-ic state, not in its state as matte or speiss, is obtained from it, ladling it from the sump or forehearth. If anybody choose to ladle from the forehearth, as a matter of course he can do so. That is here the same case. Karsten says you ladle the metal, but the slag comes in also. He don't speak of this furnace as a lead furnace, he says metal. The only place where he speaks of the special process of ladling besides that passage Mr. Grant read is in volume four, speaking of iron, where he says, that when you ladle the iron from the forehearth your slag is inclined to flow off, with shots of iron dispersed through it; meanwhile the slag runs
208 off clean when you tap the iron from the bottom. Therefore, I think when he speaks——

Objected. That opinion should come from the court and not from the witness.

The COURT: I think he has a right to express his idea of Mr. Karsten's description there.

Q. Explain this model with reference to page 473 of Karsten.

A. This is a furnace made one inch to the foot. Karsten gives on this plate, where he speaks of this figure, a scale. I have measured it and superintended the making of this model. This is an exact representation. At the same time I made a drawing, which is put up there, and which also represents that furnace on as large a scale as this model does. Here is figure 474; it is a ground plan of it, and that is the model of the figure on the upper drawing there.

209 Figure 473 is a cut or section of it through the back and front wall. That furnace is also exactly as Karsten gives it, with the exception of the upper portion that is taken away.

Q. Where?

A. In his figure- 473, 475, described on page 300. The lower eye in this furnace is six inches high and nine inches wide; I would call it more an open-breasted furnace than anything else; it comes nearer to that than the hidden-eye furnace.

Q. What are the dimensions of the hidden eye?

Ans. Six inches high and nine inches wide, shown in the figures.

Q. Would it or not be impossible to operate that furnace, built on that scale, and keep slag, speiss, and matte out of that forehearth?

A. It is impossible.

Q. For the same reason you have illustrated at length?

A. Yes, sir; of course you may shut that eye up, make it so small; have a man stand there and watch it, but that is very expensive. It would cost pr. 24 hours six dollars at least, perhaps three hundred dollars a month. If you don't do that, then it will blow out.

Q. Is it practicable to do it?

A. It is impracticable.

Q. You mean that open eye?

A. Yes, sir; it is impracticable to do it, for the reason just stated.

Q. Can you attach a slag tap to the front of that furnace at any point, as was stated, in this experimental furnace, by Mr. Grant, to run the slag out?

A. You can't, because the width of this forehearth is just
210 as wide as the forewall on the inside is; and if you come here still more at the side the slag hole would be so long that the slag would not get through, in my opinion.

Q. I will ask you, if you undertake it, would not you any way get matte and speiss in that hearth instead of clean metal?

A. Yes, sir; if you had an open eye. I can explain that better by these figures, show exactly how the lead would flow. Here is that open eye (pointing to diagram). Open in that case the lead would accumulate, to stand equally high on either side of the brasque partition, Fig. A. The red is the lead, the blue the slag. Only a comparatively thin layer of slag is formed. Of course it will blow out, if the blast comes out here. It is disagreeable if it makes only slag; this slag would flow off filled with shots of lead; hence only unclean slag is formed, contrary to smelting.

Now, then, we close it up; it does not matter whether we close it up altogether, abolishing the upper eye, or whether we put a tap somewheres there or in another place, and tap it from time to time, allowing the slag to accumulate. This figure "B" shows common slag, which is very light, lead being three times heavier.

That shows how the slag would stand, if it was pure slag, and in the act of forcing itself out this balances the lead from here down to this line here—about. Now, this is six inches high; take off
211 two inches here for the slag spout and an inch and a half for pressure, that would be three and one-half, that leaves only two and one-half inches of lead here to overcome. Three times two and one-half is seven and one-half; the distance from here to here is three times two and one-half, equal to seven and one-half. Therefore, let us suppose the slag to have accumulated in here from time to time a little, and it will take the lead out, the slag itself also passing out. This is assuming that it is the common slag; but this furnace was used for smelting litharge. The slag of litharge contains thirty per cent. of lead; it is very heavy, almost half as heavy as lead. The same thing would occur as before, only there the slag would stand lower. Now, I have assumed that this has no tap to it. In every case, of course, by ladling that very state of affairs will will occur in either case, namely, that slag, filled with shots of lead, will be produced, and the slag will pass through the lower eye.

(Here court adjourned for the day.)

212 SATURDAY, *Nov.* 18*th*, 1882.

Cross-examination of ALBERT ARENTS, in rebuttal, by Mr. MACON:

Q. I want to ask you whether you have learned anything more about this furnace described by this Karsten, and about which you

were interrogated last evening, since the former trial that you did not then know?

A. I have investigated and thought over it very close; at the last trial the fact that the slag flowed through that upper hole was sufficient to satisfy me it was not our device. I didn't care to investigate it any more, for I have built so many furnaces. I have studied and measured this since, so that I have learned more about it.

Q. Now, I want [you] to state briefly, without any great circumlocution, what the reasons are for your belief that a furnace constructed upon the description given by Karsten at page 166, 5th volume of his System of Metallurgy, is a monstrosity and incapable of being worked?

A. I didn't speak of that as a monstrosity at all. I spoke of that monstrosity in Fig. 473, of which Karsten gives a description on page 302, because he describes and says what it is for, what these eyes are for. But if that is for the same purpose as this, then that is just as much a monstrosity as this is.

Q. Do I understand you to say that you don't understand the description 860?

213 A. I understand it perfectly, as far as is goes; all the description amounts to is this, that the shaft of that furnace, the shaft from the forehearth up, Mr. Karsten describes, and gives the size of the furnace itself, the shaft, the upper, not of this lower portion; he gives the dimensions and says that that furnace is for smelting roasted matte in the Clausthal smelting works, where I have worked myself; he goes on and says the hearth, the lower portion, is not made by that; not like that furnace, but like another furnace which is used for smelting slime, concretions.

The hearth arrangement of that furnace is a sump furnace with an open breast and a tap hearth; therefore, I say this furnace with this lower portion, this hearth arrangement, is not described in Karsten as such as an entirety.

Q. State whether plate 860 describes, as appears on the plate, a sump furnace with a division between the inside of the furnace and the outside, in which division at the bottom of the crucible is an eye, communicating with the inside of the crucible and the outer forehearth.

A. On the plate that furnace appears like a furnace with the hidden eye, but it is not down in the text; and it also shows that above the forehearth is a slag eye. A is an opening, an eye; I don't know what it is for.

Q. That is the front of the furnace, aint it?

A. Yes, sir.

Q. That is where you say the slag used to be invariably tapped?

A. Withdrawn, not always tapped thin; it runs, if you have an open-breasted sump furnace; of course it runs out of itself. This is

214 a sump furnace; has no tapping to it.

Q. This plate 860 represents a furnace with a division between the outside basin or forehearth and a covered eye at the bottom of the basin, and crucible connecting the two, communicating between the two with a slag eye, above the forehearth?

A. Still it is a furnace like this furnace called hidden eye, when the breast simply descends a little further down than in the furnace with an open breast.

Q. You suppose that to be a slag eye, do you?

Ans. I don't believe in that thing at all. I don't suppose anything about it.

Q. Don't know anything about it?

A. Karsten don't describe it. I don't recognize it. It is perfectly superfluous, useless, don't need it.

Q. In figure 860 there is an outside basin you call forehearth, in which the metal flows from the crucible?

A. In which all matten masses flow from the crucible, of course, the metal among the rest.

Q. Between that forehearth and that crucible, you say there is a covered eye, which permits the overflow of the liquid contents of the crucible into the forehearth?

A. There is an opening which Karsten calls an open eye, which of course permits the flow of molten substances.

Q. In metallurgical parlance, is there any distinction between an open breast and a covered eye?

A. Only a larger opening, that is all.

Q. When it reaches certain demensions we call it an open breast?

A. There is no line of demarkation between the two. I know of none; that would, according to my idea, not be an eye at all.

215 Six by nine, I don't call that an eye, generally. An eye is small—my understanding of it; if he speaks of this here as an eye, we don't know any more what Karsten means.

Q. Taking the figure 860, do you have any guide as to the size of this communication between the outside and inside of the crucible?

A. Yes, sir; there is a scale.

Q. Tell me what the size of that is, according to the scale?

A. The lower eye about three inches or three and one-half, the upper eye just the same.

Q. How much larger is that covered eye on plate 860 than your tap?

A. About the same size.

Q. You don't call your tap or tube an open breast, do you?

A. No, sir.

Q. If you should find a hole in the wall of a smelting furnace the size of your tap, you would not call it an open breast, would you?

A. You have only reference to the width, Colonel; you have to have reference to the length as well. If it is only two or three inches wide, and it is short, you might call it an eye; but if much larger a channel; therefore that is an eye, but ours is a channel. There is a wide difference between them.

Q. The distinction is in the thickness of the substance through which the eye or channel passes?

A. That is my opinion.

Q. Has that furnace, as described by Karsten, figure 860, ever been used?

A. This furnace in 860, not as it is there; never have seen it.

Karsten don't say anything about it. The literature of metallurgy doesn't say anything about it. The furnace has been in use without that eye.

Q. Did you say on the last trial, on cross-examination, in answer to my question, that that furnace, described by Karsten in plate 860, was a very old furnace.

216 A. Very likely I did. I say now that is a very old furnace, when you take that upper eye away. At the last time I had read so many books, all of which you had pleaded so much, I may have very likely not stated it as I me-nt it, without that eye.

Q. Wasn't I cross-examining you entirely upon the Karsten furnace and model which we had in this court-room?

A. You had no model of the Karsten furnace in the court-room; you pretended it to be one; I didn't know anything about it.

Q. It was in answer to my questions you said it was a very old furnace and had gone out of use.

A. A similar thing. I don't say an exact model of it.

Q. Didn't you pretend, at that time, in that cross-examination, to give the dimensions; didn't you say the tuyeres in that furnace were not set higher than in your furnace? Did you or did you not?

A. I don't know; I don't recollect.

Q. How does it come you know so much more about that now than you did six months ago.

A. Because I have measured everything and investigated since the last time. I have investigated whether Karsten makes mistakes or not.

Q. Didn't you give your deposition before the trial came on, you and Mr. Keyes both?

A. I didn't make any deposition.

Q. You knew that plate of Karsten, the book, page, and plate, and the pleadings were before you?

A. I did more before that trial, yes, sir. I had more to do. I had my private business, my family—I can't read all there is in your pleadings that don't amount to anything. I hadn't the time to often go over all these foolish things. You have made me a great deal of work, indeed, and every body else, and useless besides.

217 Q. Tell me why it is a furnace constructed upon the description given by Karsten, and upon this description, or rather constructed as you have this constructed, can't operate?

A. Because there is an open eye. If that is open the blast will rush out of this. In the first place, that is very inconvenient. Another reason is that the blast, when it has got into the furnace, has to ascend in the furnace shaft; it is a necessity, for that blast is the reducing agent for the ore. The consumption of coal is only to create a high temperature for liquifying, not for reduction. No reduction takes place, if you withdraw this blast. It is changed, when coming in contact with incandescent coal, into carbonic oxid-gas. These gases are nothing but carbon united with oxygen, and which gas is absolutely necessary to pass through the shaft, come in contact with the ore, to reduce the metal in its combination *of* with

oxygen or as carbonates. If you do not let this gas ascend or withdraw it partially, that metal ore is not reduced to metal when it comes down here in the upper part of the hearth; it produces rich slag; moreover, the case produced here as having occurred at the Harrison works, when the furnace was one solid mass from top to bottom, on account of the insufficient blast, proves my assertions. As it ascends in the shaft it gives off its heat. If you run this furnace by that open eye, you lose that heat; if you don't let it ascend you will have to run your furnace down. If you only charge with little coal, the furnace will freeze. You have to put in a large amount of coal, and I doubt very much whether you can then run it, because if you put in a large amount of coals, the heat will
218 gradually work its way up, the ore begins to cinder on top, the whole thing stands as a mass. Mr. Fahr, of the Harrison, had the same experience. For each *of* blast the whole thing froze. For that reason, the open eye is a monstrosity. When it is shut, when you take that foolish Karsten invention away, when you do that, your furnace works.

Q. Tell this jury what prevents a man from putting his tuyere a little higher so as to prevent it being opposite to this.

A. Mr. Macon, if you please; if the tuyere would be so high that the blast could not reach that open eye, you cannot smelt at all; it would be still more a monstrosity. The place between your tuyere and the hearth surface is the hot place that you take *that* away, and then it will freeze, so that in no case it will do; that open eye has to be abolished; it is foolishness; the furnace is a monstrosity with it.

Q. Karsten says the tuyere is how high above the level of the forehearth?

A. About fourteen inches.

Q. How deep?

A. 10½ inches. Vol. 3 is a prefatory preparatory work, to teach in general what there is in metallurgy; meanwhile volumes 4 and 5 are descriptions of furnaces which really exist—existed somewhere; therefore if they did exist, he has to give the drawing there just as it was, and not otherwise.

Q. By what authority did you put that tuyere here?

A. If Karsten says the tuyere is 14 inches above the level of the foreherth, that is fourteen inches above I think.

Q. And it is then immediately opposite this open eye of his, 14 inches?

A. No, it is not; it is a few inches above.

Q. Why do you say, if this slag eye is left open, this blast will flow right through it.

A. I will tell you; when I said opposite, I me-nt in an oppo-
219 site direction without saying on the same level. I will tell you why it blows through; this furnace is not only as high as this model is, that furnace is several feet higher; when it is built with whatever material he uses the sump furnace smelts the roasted lead matte; that is a finely divided stuff. This ore in the shaft, together with the coal, lays pretty tight—the distance is some six or seven feet, Meanwhile, down below here where the air blows in the interstices

between the pieces of coal are not filled any more; there is a layer of coal, nothing else, and the distance from there to this hole is much shorter than the distance from there up to the top; therefore, it will blow out here. Don't misunderstand me; I don't mean to say all the blast comes out here, but the greater portion. You have no right to change one part and not change the other; if you keep to the hole I stick to that; therefore, I say it will blow out.

Q. How far is it in Karsten from the bottom of this slag eye to the bottom of the crucible?

A. Well, where the bottom of the crucible is you know it is on a slant. It is about, perhaps, nine inches—about nine or ten inches, more or less.

Q. He don't give any particular depth for that, in words, does he?

A. No, sir; he has his drawing there with a scale to it; you can measure that.

Q. With eight or nine inches of lead below the slag eye what would prevent—why can't you shut the slag eye and tap it when you please?

Ans. You can shut the slag eye, but then it ain't an open eye, it is a tap.

Q. A smelter would have no difficulty, would he, in keeping that eye shut and drawing off the slag when the blast—without encountering any of those difficulties you have spoken about?

220 A. If he wants to do that, wants to shut it up, he has to be mighty quick, has to work the crucible, tap everything off, raking that slag off. I strain matters for your sake, so you get your point, then you pour water, if you please, rake it up off again and then ladle. I never have seen it done, and it would be most impracticable to do. You can but take a little lead out of the basin of the crucible where the basin is eight or nine inches. You say eight or nine inches of lead, as if that was holding the slag in the middle. Now, it is not, as a fact; the column of three inches in the hearth will balance a column of three inches of lead in the crucible.

Q. I want you to say whether or not the full depth of that lead the other side of the opening here don't count in its balancing power as against the slag?

A. No, it don't. It counts from the roof of the lower eye, from there up it counts.

Q. Will you just state to the jury and court the physical law from which you deduce that conclusion?

A. From the law of hydrostatics.

Q. If we take these two bottles, and they are both the same size, and we connect them at the bottom with a communicating tube and we pour this one-half full of water, or full of water, they will each be half full or full?

A. Certainly.

Q. Do you say that because this communicates with this one it will not support just as much of a superincumbent mass as it would support if it had no communication at all?

A. That is a different thing altogether; that ain't the question here.

Q. Would it or not, just answer me?

A. Balance each other? Of course, that is a different state of affairs. You speak of two liquids in here. You speak here
221 of slag, there of lead; there is lead in here, lead inside, eight inches inside of the crucible, eight inches in the forehearth.

Q. Do you say that that eight inches wont support practically twenty-four inches of slag on top.

A. No, sir; you get the whole thing wrong. You have this blast.

Q. We have heard a dozen times the blast operated some toward breaking the equilibrium of the two bodies of metal; we know that. I am speaking here as though no blast were in the furnace. We will take the blast, if you want it in there; add to it say a half-inch or inch.

Ans. One inch of mercury makes $1\frac{1}{3}$ of lead.

Q. Do you say because this covered eye is three inches in diameter, it would take from the supporting power of the mass of lead below and in this forehearth its supporting power by three inches.

A. Don't you understand, Colonel, when you have lead down below that lead fills the eye, or nearly so-then the lead on the inside of the furnace, don't that balance the lead in the eye.

Q. As a matter of course?

A. Very well; that which is balanced by lead in the hearth here, through the eye need not be balanced by slag in the furnace; that is what I mean. The crucible is ten and one-half inches; that is pretty nearly filled with matte, which don't come out at all. This lead in the eye balances itself; therefore you have to take that off from this column; you have only seven and one-half inches left; take that seven and one-half inches, you have a slag spout here; that must be at least two inches deep; consequently if that crucible is tight even, you can't fill that up except to $8\frac{1}{2}$ inches. Take
222 this three inches off below, it leaves only $5\frac{1}{2}$ the pressure of the blast alone, with balance $1\frac{1}{3}$ leaves only 4 inches, so that practically, when this is full, you have only to overcome the weight of four inches of lead in the forehearth, or three times the amount of it of slag; therefor- twelve inches. This slag stands twelve inches from the roof of the lower eye; since that is eighteen inches up to the tuyere, the slag will only rise within six inches of the tuyere, when it will pass out here, through the hidden eye, when everything is full.

Q. When that is full and this is on the same level—practically the same level—minus the effect of the blast inside of here, and those two vessels are on a practicable level, how deep is the lead in here, if this is full?

A. The lead in this is, when full and practically on the same level, ten inches deep—would say about 9 inches and one-half.

Q. If you have no blast?

Ans. Certainly; just as represented on this figure, A.

Q. Imagine this is full—this inside is on a level with it. Now, I want to know how much slag that ten inches of lead will support?

Ans. You haven't ten inches of lead; you can't fill that spout two inches.

Q. You have given it as your opinion, as a scientist, that a furnace constructed after Karsten's plan could not be worked.

Answer. Yes, with the eye open; no, when the eye is closed. Mr. Grant testified to the same thing.

Q. Do you believe he constructed that furnace, of which this is an accurately correct model?

A. I don't believe he could have by the results he has had; there must have been some other dimensions.

Q. Do you believe that Mr Grant constructed a furnace at Leadville, and operated it successfully, of which this model is a correct representation?

A. I don't.

223 Q. Do you believe that Professor Bieger saw a furnace, of which this is an exact model, and worked very well at Leadville, in the Grant Smelting Works?

A. I don't, because—I wish to explain. I don't want to convey the impression as if I diden't believe those gentlemen—but they are mistaken. The Professor has not testified whether he measured that furnace; it may have been a similar furnace constructed on that principal-, but not like that; that is what I mean. Their testimony was not so accurate as to refer to every particular things on it; therefore, I say I don't believe it, because I know it won't do it.

Q. You believe Prof. James told the truth when he said he saw that furnace going up, saw it work afterwards four or five days, in two different ways?

A. I have no reason to doubt his word. I don't know anything about it; I don't know these gentlemen sufficiently to tell as to their veracity.

Q. You know Messrs. James, Smith, and Grant have smelted in this country for some time, and that they have made it a success?

A. They have learned to make it a pretty good success now, I think.

Q. When Mr. Grant swears that this is an exact representation of the furnace he worked, you don't believe him when he says that he has made this furnace from Karsten, do you?

A. He may have built a shaft from it. This is the furnace proper.

Q. This is the only thing in dispute between us—this little part of the furnace?

A. I don't know anything about it; I don't believe it because I know it won't work that way. He must have changed some dimensions; he has changed the whole thing. It wasn't a Karsten

224 furnace according to my opinion.

Q. When Mr. Grant swore that he took plate 860, description 166, vol. 5, and constructed a furnace by that alone, that it worked properly, correctly, and it produced clean lead, and he could tap it or ladle it as he pleased, you believe that wasn't so?

Ans. I don't care what you believe; I don't believe that such a furnace can do that. I dont believe it was a Karsten furnace; it was a modified Karsten furnace, no doubt; I believe it was modified. Another reason for my belief is that his model at the other trial was a different thing from this, of entirely different proportion, if

I am not mistaken. My idea is, he swore that time that that was the model he had worked; if that was the one this cannot be it.

Q. You swore at the last trial to something you take back now?

A. That was something I hadn't investigated so much as now. I do not deny now what I swore then.

Q. Mr. Grant comes in after further examination and swears positively this is a correct model of his furnace.

A. I have not listened so closely as to know.

Q. When Mr. Grant swears he took this plate alone to the master mechanic at the Colorado Iron Works, and he produced this, do you believe him or don't you believe him?

A. I testified yesterday, Colonel, that the inner lines appeared to be substantially correct—otherwise the model——

Q. I ask you if you believe what he said, that the master mechanic made that model from figure 860?

A. Well, I expect he did.

PLAINTIFFS' COUNSEL: He stated that he made a draft.

Q. When Mr. Grant says he took the exact draft of plate 860 down to the master mechanic of the Colorado Iron Works, and had him to made a model, and he produced this, you don't believe
225 that is exactly it either—the model is not according to the plate?

A. No; only a part of it is.

Q. How does it come that both the master mechanic in making from this model should depart from this plate, and Mr. Grant should depart from it when putting up a furnace at Leadville to determine whether the furnace was practicable or not?

The COURT: You can't ask that.

(WITNESS: How can I tell.)

Q. A furnace constructed upon that model, will it work and produce clean lead?

A. No.

Q. Why?

A. I explained to you if you have that open eye, I suppose that is what you call it, to keep open for the same reasons I have stated; shall I state them over again?

Q. No, sir; not any further than what you believe.

A. I don't believe it.

Q. If it is closed temporarily, how will it do?

A. As I explained last night, the slag will get up a little, and that little is sufficient to press it out, the dimensions are so low. That was the state of the art. I would say nowadays it is much different.

Q. In a furnace of that description all of these difficulties about the slag entering this covered eye or lower eye is obviated by simply a change in the dimensions, is it not?

A. You have to change the furnace, of course. If you put your tuyere higher, and put your hearth higher, perhaps in the same ratio, make that hearth ten inches higher, take that slag eye away, put it somewheres else, make that wall thicker, that front wall, be-

cause it will break, then it will do it, do it successfully; in other words, if you modify it completely, then you get this useful result, then you can do it.

Q. If we take and put these two tuyeres a little higher, set the slag eye a little deeper, set the slag eye instead of here around here?

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A. It would not be Karsten's furnace.

Q. Whose would it be?

A. I don't know.

Q. Would it be yours?

A. If that thing begins to work, then it is our work. I said before we claim that any basin attached to an ordinary furnace receiving neither slag from below or above, but clean lead only, is our basin.

Q. I understand you to say any attachment to a furnace so constructed that the lead flows into a forehearth or lead-well in a clean state and rises to a common level in the outside vessel with the contents of the inner crucible, and the slag is withdrawn away from and at another side of the furnace from where the lead-well is, is your invention?

Answer. Yes, sir.

Q. And if it is so constructed that it will produce the pure lead into the lead basin in front?

Ans. That is what I understood at first.

Q. But if the furnace is so constructed that the lead basin and the slag tap are both upon the same side, it is not your invention, is it?

A. If the slag runs into that any, then it is not.

Q. Suppose it is kept out by setting it a little to one side?

A. That is impracticable; you can't work it.

Q. Suppose it is run through on sheet iron and carried out?

A. I will permit you to do that; that is not our device.

Q. But if it is set to one side it is?

A. Yes.

Re-examined by PLAINTIFFS' COUNSEL:

Q. There has been used all the time the half of this furnace which is so sawed in two, to represent the size of this Karsten under eye. Is that at all like that with reference to the size of the open eye?

A. Well, it don't appear in this model, because this is almost shut up here entirely, so that when you look at this model it represents that hidden eye as being about a quarter size of the representation here.

227

Q. Before it is covered up with glass, and before something is put in there?

A. Yes, sir.

Q. Would that be a very material difference when you come to test that model with reference to the Karsten draft 860?

A. Why, certainly it is.

Q. I understand you say, if you test it from that, notwithstanding that eye should be left open, and you tap the slag somewheres else, still slag, speiss, and matte would get in here. It is not a matter of opinion, but it is a matter of figures. It is shown by your drawings there?

A. Yes, sir.

FRANK FAURE, sworn in behalf of plaintiff in rebuttal:

Q. Will you examine that cut, 860, Karsten's atlas?
A. Yes, sir.
Q. Have you taken the measurements of that cut?
A. I have, sir.
Q. Have you taken it from the scale given on the map?
A. I have, sir.
Q. Will you take that section of furnace model introduced here, and state whether, as it is represented, it is similar to that, as you can observe it from the glass?
A. In the glass this upper eye is left out; the glass covers this upper eye.
Q. State, as you observe the section model before you, where the difference is from the Karsten cut. Give the relative proportions of the model and the relative procortions of the cut, and state if they are in any way similar.
A. They are somewhat similar, not exactly the same.
Q. What is the difference?
A. It seems to be the height between the top of the upper eye and the bottom of the lower; is larger than represented in the furnace.

228 Q. What is the relative proportion of the hidden eye, as exhibited in that; how much smaller in proportion?

A. Well, this black stuff here prevents; one cannot say exactly how large this hole is, but the opening between the two black marks is no smaller than it ought to be, according to the cut.

Q. Compare that section with this, and state if there is any material difference between the two, in representation, as between the hidden and the open eye.
A. The open eye by the scale is three inches, and the distance between the bottom of the open eye and the top of the hidden eye is seven and one-half inches, consequently it would be twice and a half. This model seems to be very nearly correct, according to this drawing.
Q. Is there any material difference whatever in the height of the partition wall, which appears to be larger in this model?
A. In this, that is the brasque.
Q. Is that change material, in the application of the sections, between the two drawings?
A. Yes, sir; that is material.
Q. You say this section of the furnace is a fair representation of the cut in Karsten?

The COURT: It is conceded that it is made smaller inadvertently. That is all there is of it.

Q. You say that that is not a fair section in regard to proportion with the cut in Karsten?
A. Yes, sir.
Q. State to the jury whether such a furnace as that could be worked by closing the open eye, so that the slag would not be forced into the forehearth.

A. At least it must at times; in practical working it would be.

Q. Could such a furnace as that model describes be worked?

A. You mean with the eye open? I would not want to work it; the brasque would come out with such force that nobody could
229 stand in front to ladle out lead, take off slag, or anything else.

Q. Have you read the description given in Karsten as to this plate 860?

A. I have.

Q. Does Karsten give any written description of that figure?

A. I believe he does.

Q. How much of a description does he give? Refer to that part of Karsten.

A. I don't know, by word, how much of a description he gives of it.

Q. Examine the cut in Karsten, figure- 473–'4. Is that cut given upon a scale?

A. Yes, sir; that is the scale.

Q. Have you taken the measurements of that cut?

A. I have.

Q. Could a furnace built upon that scale, on that figure, be practically operated?

A. There are the same objections to it as to this one; there is the same open slag eye, and the dimensions below are still more unfavorable, because the distance from the bottom of the crucible is six inches instead of three inches, leaving a larger opening below.

Q. Could a furnace built upon that scale, that description, be practically worked?

A. Not in the way it is represented in this cut.

Q. What would be the effect of the molten masses flowing into the forehearth?

A. In the brick work of the furnace, if the eye was closed, they would enter the forehearth.

Q. Could such a furnace be operated practically with that eye open?

A. No, sir.

Q. Would you regard the changing of the distance between the hidden and the open eye a material change in the art of smelting, as it belongs to the building of a furnace, a change in regard to the distance between the open and the hidden eye, from the drawing?

A. Well, it is a material difference in some respects. To what purpose do you mean to apply it?

230 Q. I mean in its application to the description of the furnace given from the drawing. In its application as it is given and as it is used, would you regard the extension of the brasque, the distance between the open and the hidden eye, a material change?

A. Certainly it is. It all depends upon the dimensions; if you change the dimensions, it is a material change.

Q. State as to whether the hidden eye or open eye be large or small, as to its practical application in the art, would be a material change, whether you make it large or small.

A. Yes, sir.

Q. Do you remember a model that Mr. Grant introduced at the former trial?

A. I remember it somewhat, not very distinctly.

Q. Did you make the measurements of that model at the time—did you examine it?

A. I examined but did not measure it.

Q. From your knowledge of that former model and its comparison with this model, would you say that that represented one and the same furnace?

A. That I could not remember; I could not say.

Q. You could not say whether there were any material changes as to that?

A. No.

Q. Examine that section of a furnace [refers to model]. Would you make the same answer as to these proportions of the open and hidden eye?

A. I could not say.

Q. Do you remember the size?

A. I don't say that I could state.

Q. You don't remember the relative proportions now, I believe you stated, of the furnace?

A. It has slipped my memory what I did state at the time, because I have not kept it in mind.

Q. I believe I asked you the question, as to your own judgment, as to whether a furnace built upon that model could be operated?

231 A. The moment I left this court-room I never had my mind on it. I don't remember what I did say.

Q. I am speaking now as to whether a furnace built after a model like that, in those proportions, whether in your judgment such a furnace could be practically operated?

A. Not with the eye open; close the eye the slag will enter the forehearth through the hidden eye.

Q. Then to get the clean metal from such a furnace, what would be necessary to do?

A. Either to take a fork and take the slag off, or else tap it; tap it in the old way.

Cross-examination, FAURE:

Q. I understand you say a furnace constructed after figure 860, plate 41, is not capable of being worked?

A. Not as long as the eye is open. That is what I said.

Q. Were you examined in this case at the former trial? Frank Faure is your name. Did you swear then that you knew that that furnace, as represented in figure 860, was worked and was an iron furnace?

A. I did not swear it. I swore that iron had been ladled out of a furnace; I didn't swear out of this furnace.

Q. I read "what sort of metal is that (pointing to the metal)?

"A. Iron.

"[Q.] It has been done, ladled out, iron underneath the slag; for lead it has never been done?"

Answer. Exactly.

Q. You say this device was used for iron, not for lead?

[A.] I don't know; it has been used for lead. I don't say in that furnace.

Q. What furnace were you talking about when you said a furnace?

A. I was asked whether I knew that metal had ever been ladled out of a forehearth. I stated I knew; I had heard of it. Iron had been ladled out of a forehearth.

232 Q. Will you tell the jury what furnace we were discussing? Do you call tapping metal, a device?

A. Yes; I don't know whether device is a metallurgical term or not; if you say it is, I will not contest it.

Q. I will go further. "Then you say this device was used for iron, not for lead? I know it has been used for iron, but I do not know it has been used for lead. What furnace were you talking about when you said you 'think it is not?'"

A. They get out iron with slag on top of it by the same device; they hold the slag back, pouring the iron out.

Q. So they could put something here to prevent the slag from running into the iron. I will ask you if the same operation could not be used for lead?

A. It would not escape longer than twenty-four hours. This division and so-called forehearth is entirely different from ours. This is made of clay, and has to be renewed once in every twenty-four hours' time, because the slag running on it and under it will destroy it. According to your recollection now, I was questioning you upon what we call the model of a Karsten furnace?

A. I don't know; bring the whole of the questions.

Q. Did we have at that trial any other model except that?

A. Did you question me on that model, then prove it by witnesses.

Q. Then I put this question: "Why does this brasque last longer than ——? It does not; iron furnace — repaired every twenty-four hours. Is there any reason why it could not be constructed of imperishable material?

A. You want to prove to me I testified on this furnace; prove it.

Q. "Is there any reason why this extension below the slag eye should not be used?" You say "There is nothing."

Ans. I don't think I said there is nothing to that; I think
233 that is not correct; there is no sense in it; I didn't say that.

Q. That is always a convenient way. Now, then, you don't know whether this model is exactly like the model we produced at the last trial or not?

A. I could not remember; could not from memory state whether it was the same or not. Answ. I could not, consistently with my oath. I don't say, don't know anything about it.

Q. You say the reason why a furnace constructed after 860 could not be worked is because the dimensions of the crucible are not properly proportioned?

A. No; I didn't say that.

Q. Let us have what you did say?

A. I said that furnace could not be practically operated as long as that eye was open; and if the eye was closed, it could not be operated with the same results as in Keyes' and Arents' patent, because not only lead, but slag and matte enter into the fore basin. It would do so, because this furnace described in this has not suitable dimensions to prevent it; in other words, the measurements are not as they should be, in order to produce those results.

Q. If this outside basin was made higher, and the slag eye set a little higher, the tuyeres a little higher, would it, or would it not, work?

A. If you make another furnace out of it you can.

Q. Do you call it another furnace to raise that eye two inches?

A. You ask not only to change the eye, but to make the crucible higher, to gut the slag eye on the other side. If you make a great many changes, in fact, make one important change, you can change it into a Keyes and Arents.

Q. That is all it lacks?

A. A good many things else.

Q. You believe that furnace is not a practical furnace in its
234 proportions, as it is produced here?

A. This furnace will let the slag, matte, and speiss enter into the forehearth, and therefore it will not work on the plan of the furnace of Keyes and Arents.

Q. Did you make any measurement of this, as compared with that?

A. I did, sir.

Q. Is it substantially correct? You don't believe it will work so as to produce clean lead in this metal basin, and separate it from slag?

A. It cannot.

Q. When Mr. Grant says it did, you don't believe him?

A. Mr. Grant did not actually build the furnace. If I heard right, Mr. Grant said he gave the copy to a master mechanic. Why wasn't the master mechanic here to testify? Therefore, saying that Mr. Grant is not correct is not necessarily that Mr. Grant intended to say anything untrue.

Q. If Mr. Grant did say that he built a furnace in Leadville, which operated so as to produce clean metal, separate from the slag, and that this model is an accurate description, representation of that furnace, you think that he said what is not true, do you?

A. If he will give me the measurements; I don't mean to say that Mr. Grant lied. At the same time, I mean to say his furnace was not built according to those dimensions, or it could not work.

Q. When Professor Bieger says he saw it work, and that he believed it to be an accurate description or presentation, or a furnace built according to plate 860, you think he is mistaken?

A. Mr. Bieger may have stated he believed it to be; he didn't say it was; he didn't say so.

Q. If he did say so, what is your opinion?

Answer. As long as he didn't say so, it is no use. If he did say so, it is not correct. I would say he was mistaken.

Q. So with Mr. James and Mr. Smith.

A. Yes; exactly.

235 Q. When Mr. Grant says he had an accurate draft of this figure 860 made, took it down and gave it to the master mechanic at the Colorado Iron Works, and he made this furnace-model from it, do you believe that this is true or not?

A. That model is probably very near correct; that does not prove that his furnace — in Leadville.

Q. Do you think a man who was building a furnace for the express purpose of testifying in court would be very likely to make it according to the plate?

A. There are witnesses on both sides swearing to this or that. I swear to what I know; not to what Mr. Grant might have done or might not have done.

The plaintiff then recalled as a witness in rebuttal ANTON EILERS, who had been duly sworn, and who testified as follows:

Q. Have you examined the figure 860, table 41, of Karsten's atlas, showing a sump furnace, with an open and a hidden eye, and the other figures on the same table, showing the different portions of the furnace?

A. I have.

Q. State, as concisely as you can, to the jury, whether or not that furnace is constructed, in all material and substantial details, in accordance with this model that I hold in my hand?

A. To tell you that I would have to have the scale and see, because the parts of that are important, so far as I can see, in order to be sure.

Q. State, first, whether or not it lacks any of the essential details of a furnace according to that cut, aside from the particular details of the scale?

A. This, without measuring, seems to contain everything, excepting that outside basin.

Q. Has it got a tap canal?

A. The channel, of course, is not there.

236 Q. State whether, in the operation of that furnace, as it is shown upon that tabl- 41, figure 860, and the other figures showing the different parts of a furnace, the tap hearth and basin is one of the essential elements to the operation of a furnace.

A. If it was not essential it would not have been put in according to this drawing.

Q. It is intended to be drawn according to that drawing, description of Karsten; the clean metal is intended to be drawn from this forehearth by an old tap and basin?

A. Yes.

Q. State whether or not a furnace constructed approximately according to that model, aside from the particular details, would operate and run practically, and produce clean metal in any way—metal only separate from speiss, matte, or slag.

A. It would be hardly possible at all to produce clean metal alone in that forehearth.

Q. Why?

A. It is on account of the relative sizes of the communicating channel or hole below there; the hidden eye, as they call it here, all along; the height of the dividing partition between that hidden eye and the slag eye and the position of the tuyere.

Q. Have you carefully examined the scale, measured it carefully, and made mathematical calculations from the widths and height and sizes, which show the proportion of those eyes to the furnace, to determine this question?

A. Yes; I have.

Q. Illustrate from that drawing, where the red shows the metal and the blue the slag, to the jury; then tell them why, if that open eye was moved, changed to slag tap, nevertheless you would get speiss, matte, and slag in your forehearth, or what Mr. Grant is pleased to call the lead-well.

237 A. According to the drawing on this plat this crucible is ten and one-half inches, as near I can get at it, and this dividing partition is seven and one-half, leaving three inches of a hole down here; that upper hole is also three inches. If that hole was closed during ordinary running you would have raised the slag above it; you have to have enough slag in there so as not to have it blow; in ordinary smelting you would not avoid that. If that slag was not tapped at all, of course it would accumulate in here very quick, and it would come up to the height of the tuyere before it ever got there; it would press every particle of that lead, would run over, that is, at least two inches deep; these two inches, of course, you cannot fill; you cannot fill this with lead up to two inches, that height here; it is lower than that. Then the pressure of the blast, ordinary blast, is from an inch to an inch and a half. The lead will then be pressed down on this side from an inch and a third, possibly, to an inch and three-quarters on this side, and of course rise on that side; that will be three and one-half at least, which leaves from a little over seven inches, about four—a little over perhaps. To overbalance that it would require three times that weight of slag. Then it would press it all out. If a man could stand there and treat this thing like a plaything, he might manage to get in very little slag at a time. It is impossible in practical working with men that ever have a margin to go on.

Q. State to the jury the difference in the practical result, in your experience as a smelter, from operating a furnace according

238 to this model, that has been sworn to be in exact accordance with that plate, with reference to obtaining clean metal, and the operation of a furnace with this lead-well attached, according to the specifications and this model What will be the difference in the result obtained?

A. The difference, and the important difference, between this and that, and the only real important difference, is the height from here to here, that and the total height of this basin.

Q. What is the difference as to the result as to what will get into that lead basin or this forehearth.

A. The difference is that in this you cannot possibly get it into

your forehearth; under ordinary pressure you can press it out by putting ten inches of blast, but in the ordinary way of smelting you cannot possibly get your lead; and here you can.

Q. In the ordinary way of operating the furnace, of which this is a partial model, and this a complete one as we claim, what will be the result here; will you or not continually get a certain amount of matte, slag, and speiss, although you move that slag eye around to the right or left?

A. As soon as you have that slag eye only seven inches or seven and one-half, it would be almost impossible to run that furnace to advantage at all; that is, to get clean lead. Of course, you can run the slag through and conduct it off, and all that sort of thing. In the case of that, with the proportions as they are given there, and as I have always built them on the furnace, you can't get the slag; if you divide from that—if, for instance, you put the channel about here, not through the bottom, and as low as that is—
239 you can get slag into that, too. That is not this thing.

Q. You have read and are familiar with the specifications in the plaintiffs' patent?

A. Yes, sir.

Q. You have read and are familiar with pages 318–320, in volume 3, and 164–166, vol. 5, of Karsten?

A. Well, I could not tell whether it was that or not, because there are too many figures to retain at once. I have read that relating to this; what little is said about this.

Q. About this other figure in here?

A. Oh, yes; I know that. That is a description of a different furnace. I have read page 320.

Q. You have glanced at Volume V, page 166, the portions introduced in evidence?

A. Yes, I have read that.

Q. I will ask you to state whether or not you find anything in Karsten there which, properly interpreted, will guide you in constructing anything substantially similar for the purpose of withdrawing clean metal from a furnace when in operation to that you find defined in the specification of the plaintiffs' patent. You don't find anything in Karsten from which you can construct that furnace unless you alter these proportions that I have been talking about?

Objected to. Objection overruled.

A. Have to alter these proportions, if you have Karsten's furnace.

Q. State the difference in the result obtained from constructing a furnace according to the description that you have read in Karsten and the description contained in the specifications of the patent.

A. The result obtained in operating these furnaces is quite different; as I have said before, the result in working that furnace will be always that you get more or less slag in with that metal in
240 your forehearth. The result here is you get no metal if it is constructed that way.

Q. Do you find from the description in Karsten which followed in the construction of the furnace will produce from that furnace into any outside basin clean lead unmixed with any other matter?

A. No.

Q. To construct a furnace so as to produce the same result as the Keyes' and Arents' lead-well, did you or not have to make, in the construction of it and arrangement and combination of the different parts, material changes?

A. Very much so. To make a practical furnace and to reach the result, you have to make very material changes from the drawing in Karsten.

Q. Is it practical, when you consider, take the width of that furnace on the inside, that Karsten furnace, and the width of that forehearth, to put a slag tap in front of that furnace and run the slag out so it will not find some other slag tap and get in?

A. That will depend on the width that is open there, and what you use, and so on.

Cross-examined:

Q. Mr. Eilers, have you made any exact measurements since the last trial of this case?

A. Yes, sir; on the plate; also on this model.

Q. In Karsten's work, at page 166, in giving dimensions he don't give the dimensions of the crucible at all, does he?

A. He does not say anything in the text; he refers to the figure given here, an exact scale.

Q. And from that you deduced that the crucible was about how deep?

A. About ten and one-half or eleven inches. The slag eye being three and one-half inches, measure it and reduce it.

Q. That is, the depth of the lead from the bottom of the slag to the top of the lead eye or covered eye would be reduced by the diameter of that covered eye? 241

A. Yes, sir.

Q. You think that as it was marked out in that plat or figure, and described in Karsten at 166, that it would be atmost impossible, or, practically speaking, impossible, to keep some of the slag and other material from flowing along through that covered eye into the lead basin on the outside?

A. Yes.

Q. What would obviate that in Karsten's model or furnace—that flowing in of the matte or slag?

A. An alteration of all those proportions I have pointed out, the height and position of the lead-well, the depth of the crucible, and height of the tuyere over the hearth plate.

Q. You would have to resort to these changes in order to make it work completely to answer?

A. To keep the slag out simply; you would have to make other changes to make it work.

Q. In lead smelting the lead inside of the crucible is usually about an inch and a half lower that it is in the lead-well outside, is it not?

A. Well, it is generally two inches and more; not on account of the pressure alone, but because there is always a slight layer of matte on, which is very heavy, too.

Q. When the lead smelter in this country finds that his lead inside the crucible is five, six, or seven inches lower than it is on the outside in the lead basin, the smelter is not working properly. The lead-smelting furnace in this country is so constructed that, in ordinary parlance, the top of the crucible is tapped, comes up to the slag eye, doesn't it?

A. Yes; certainly.

Q. In the Karsten furnace you think there is too much slag below to keep the lead clean in the lead-well?

242 A. You have the chance to get the slag column so high as to make that slag column to drive——.

Q. In the Karsten furnace, as depicted in these plates, described at page 166 of his works, volume five, if the workman at the smelter should tap out the slag often enough, he could avoid the pressure of the slag upon the lead, so as to force it out of the crucible, and allow the inflow of slag to the lead basin outside?

A. That is the alternative that I have been speaking about. That can be done not to advantage at all. It can be done by tapping that slag every minute and shutting it up every minute. It is impracticable, entirely.

Q. You testified in this case before, did you?

A. I think so.

Q. Did you then say, taking the Karsten furnace as described in figure 860, and at page 166, volume 5, of his System of Metallurgy, and attaching and putting the slag tap to one side of the furnace, it would be the Keyes and Arents device?

A. I dont believe I had any reference to that particular figure; I think we talked only about the other figure, but I don't remember. I talked about a furnace at that time; I don't know about what. I don't remember having talked about this furnace at all, but about the other furnace on the other plate, mentioned in Karsten.

Q. When you were being questioned, we will say it is 473, to suit you, did you then say that if Karsten had put the tap to one side it would have been the Keyes and Arents device?

A. I don't believe I did; don't know whether or not I did.

Q. "Q. State if there is anything in Mr. Karsten's description, in his words or his figures, to hinder you or the smelter from

243 having it here if he chooses to do it.

A. I understand it is the slag eye.

Q. You say Mr. Karsten did not indicate, either by his drawings or descriptions of this furnace, that the slag is to be turned away so as to avoid this basin?

A. I say he does not say it in his description or in his drawings, and I know it was not mentioned in this cause. When I read metallurgy, anybody who knew anything about it agreed, so far as I know. I studied metallurgy under Prof. Kerl; he never mentioned anything of the sort. I presume it was not known.

Q. State if there is anything in Mr. Karsten's description, in his

words or his figures, to hinder you or the smelter from having it here if he chooses to do it.

A. No; not at all. A. I told you I could do it by making it a little deeper; you have exactly the Arents device." A. Exactly; that is what I say to-day.

Q. Making what a little deeper?

A. The crucible and the whole thing. That is, of course, I don't mean that, I cannot—that is hasty; exactly the Arents device—because there are other things that have to be put in to make it practicable.

Q. We want to understand one another. Therefore, I put the question so I think you will. Did not I ask you in that cross-examination what was the difference between the Karsten furnace, as described in his book and in his figure 860, the difference between the furnace as described at page 166 of Volume V of Karsten's Metallurgy, and the Keyes and Arents furnace?

A. I can't remember, it is too long; I really did not pay any attention.

Q. "Q. State the difference between Karsten's and Keyes'?

"A. The most plain difference is, that in this there is a tap
244 for the slag which does not exist in the Karsten." A. That is the most plain appearance—a tap; I hardly think I would have said it. That is probably a shortcoming, it seems to me. I don't think I would express myself that way. That is not the plainest difference. The plainest difference is the h-ight. There are various differences.

Q. Have you ever read the Keyes and Arents specifications?

A. Yes, sir. They say "a suitable furnace;" when I want to construct a furnace of that sort, the suitable dimensions are the important thing.

Q. Do they claim anything about the size of the furnace or method of construction?

A. No; they say they can attach this to an ordinary furnace by making these dimensions suitable dimensions.

Q. Do they say one thing about suitable dimensions?

A. If it is suitable dimensions it is certainly agreeable to it. I will be glad to read it. I did not learn it by heart, Mr. Macon.

Q. "Q. This invention consists in the use of a basin placed at a suitable elevation above the bottom of the furnace." Do you call the basin the furnace, or the crucible the furnace?

A. No; but I call this suitable elevation the thing I refer to.

Q. Do they, in these specifications, mention one single thing about the size or dimensions of the furnace?

A. I say not; they say only it can be attached to an ordinary furnace, I suppose a furnace in use at that time.

Q. At that time ordinary furnaces were some ton, some 15, 18, to 30 tons' capacity; they were just as ordinary of one capacity as another, were they not?

A. Well, not in this country; no.

Q. What was the ordinary capacity of a furnace when Keyes and Arents built this thing?

245 A. I suppose about ten or fifteen tons.

Q. Did you hear Keyes and Arents say that when they made their invention it was 25 tons?

A. That was not an ordinary furnace, because it would have a deeper crucible than they would have had.

Q. You infer a man cannot run the Karsten furnace because of the dimensions he gives?

A. I don't infer; I say it is so. I say the laws of physics prove it; that is what I say.

Q. You heard Mr. Grant testify that he took Karsten's description, as given at page 166 in his fifth volume of the System of Metallurgy and figure 860, and built a furnace in Leadville of which this is an exact or practically exact model, and that it worked; do you believe it?

A. I did not hear Mr. Grant say anything of the king; Mr. Grant did not say a word about the hight of this dividing in here in his testimony, and that is what it depends on, the whole of it.

Q. Take that, or this in Grant's model; how far is it over?

A. I don't know; if that is seven inches it won't work.

Q. Did you hear him say he built his furnace by the figure?

A. I believe he said so; he did not say a word about the exact dimensions.

Q. If a metallurgist says he has built a furnace by a certain figure, does he mean he has exercised his own discretion or rather that he has followed the figure?

A. He should do so; but that does not prove anything, or show at all that it was those dimensions. It depends on physical laws whether that with seven inches in there can work or not.

Q. I ask you whether, when a metallurgist says "I constructed a furnace according to a certain figure," he means that
246 he went by and observed the measurements as pointed out in the figure?

A. He should do so; yes, sir.

Q. Did you hear Mr. Grant say he had constructed a furnace in Leadville according to that figure or by it?

A. No, sir; I did not, whether he said "by that" or "according to it;" did not take the trouble of memorizing everything I heard.

Q. Assuming he did say he built his furnace according to that figure, and that it did work and produced clean lead, and it would separate the slag and other material so that he could get clean metal out of his basin, do you believe he told the truth or told a fals-hood?

A. If he should say exactly those dimensions, and he said it worked, I would not believe it; but he did not say so.

Q. You are putting theory against fact.

A. This is no theory.

Q. Did you ever build a furnace according to that?

A. I never did. I have seen furnaces that were constructed much more favorably than this thing that did not work—would let the slag out every time. I think Mr. Grant himself told you that can be done with his own furnace.

Q. Until lately you were engaged in smelting in Leadville?

A. Yes, sir.

Q. Your attachment was a Keys and Arent attachment?

A. Yes, sir.

Q. Do you ladle the metal or let it run over in the basin?

A. No; I tapped from this basin into a cooler, simply a hole an inch and a half below the top of the basin.

Q. A little hole bored in here?

A. Yes; about two inches below the top of that basin.

Q. Ladled it out of there?

A. Not in front of it.

247 Q. If this forehearth, on the Karsten furnace, was made a little higher, the slag eye set a little higher, and the tuyeres set a little higher, as you say it ought to be, state whether the metal would flow out clean through the covered eye.

A. It does not.

Q. Would it?

A. If you make certain changes on that, in regard to these dimensions that I have mentioned, you mean make something that will work like Keys' and Arents' patent; but to make it a success practically you have to do several other things.

Q. What is that?

A. For instance, you can't make that out of brasque.

Q. They don't put in fire-brick wall?

A. They don't; but they *but* the elevation above that thing.

Q. Now, if the Karsten furnace, as it is described in figure 860, page 166, Volume V, of his System of Metallurgy, were so altered, as you said it was necessary to alter it to make it produce clean lead in the lead basin, would it then run through the tap hole into the lead basin continuously, if you left this tap open, as yours does in Leadville?

A. If you leave that little *pap* hole on the side here—there it is, and here is the cooler that the lead runs into—why, of course it would, as soon as you come near these dimensions. That seems to be in the figure; it seems that that lead basin is separated from the real wall of the furnace by some three or four inches, as well as I can estimate it.

Q. Does the Keys and Arents lead basin, in fact, set up against the wall of the furnace, as here in this model?

248 A. Well, it always did, as far as I remember, until I myself was, I think, the first to put it right alongside the wall, making this thicker; that figure seems not; that particular basin is several inches away from the wall.

Q. It is not true?

A. It is immaterial whether that comes to here or there.

Q. In practice, generally, how is it, next to the wall?

A. Well, I have gotten it in the wall; others have it further off; it is of no importance. In the specifications there is no scale by which you are governed, as far as the horizontal distance from the inside of the furnace is concerned; you can set it within a reasonable distance so that the lead does not get too cold.

Q. By Judge GRANT: Is not the mode of withdrawing the molten

metal, in Karsten's figure 860, by a tap connected with an outside basin the same in principle as Karsten?

A. The principle, of course, has got to be the same.

Q. And the objections you make to Karsten's are to the furnace here?

A. The objections I made are to the dimensions, to the proportions, various things.

Q. Suppose you applied Karsten's mode to that furnace, would it not produce the same effect in withdrawing the metal out of the furnace? Suppose you apply the Karsten mode of a tap connected with an outer vessel, would not it act precisely on the same principle?

A. Do you mean to say if you made this here horizontal?

Q. Would not it work exactly?

A. No, sir.

Q. Would not it act on the same principle?

A. The principle of communicating vessels is the same, of
249 course; now, let this come down here; of course, we can dip out the whole thing.

250 Professor —— HAHN sworn, in rebuttal:

Q. Have you examined and are you familiar with the portions of Mr. Karsten's Works on Metallurgy, and the Atlas, table 41, figure 860, which has been introduced in evidence here by the defendants, — you have heard so much talk about?

A. Yes, sir.

Q. You have examined them, Mr. Kahn?

A. Yes, sir.

Q. First, I will ask you whether you have also examined this model furnace?

A. Yes, sir; I have.

Q. What do you say with reference to that model correctly representing, according to a scale, in all essential and material particulars, a furnace according to plate 41, figure 860, and other figures showing the other portions of the furnace?

A. That is a correct representation of the figure, as far as the lower part of the figure is concerned.

Q. By that plate, and the description you find on page 166 of the fifth volume of Karsten, refer-ing to this table, how is the molten metal withdrawn from the forehearth of the furnace; how is it, according to that plate and figure, constructed?

A. An ordinary tap hole.

Q. An ordinary tap hearth and basin, the same old mode thath as been talked about so much?

A. Yes, sir.

Q. Is that the essential and particular way that Mr. Karsten constructed, according to his plate, so that the metal shall be withdrawn from the forehearth of the furnace on the foresump?

A. Yes, sir; according to the drawing.

251 Q. Have you examined this model that has been introduced here as illustration, by the defendants, of a furnace?

A. No; I have not examined it closely.

Q. Have you looked at it?

A. I have seen it, looked at it.

Q. Will a furnace constructed according to that model, approximately in some parts like the Karsten model, plate, or scale, practically operate and produce clean metal in this forehearth or foresump if you should take the open eye away and put it to one side and make a slag exit or slag tap of it?

A. If that ore is melted in this furnace it cannot get clean lead in the forehearth.

Q. Even if this slag eye is turned into a slag tap and moved to one side of this forehearth?

A. Yes.

Q. You may tell why.

A. Because of the distance from the lower edge of the slag hole.

Q. To make the slag tap to one side, will that change even?

A. With that change the slag is bound to enter the forehearth.

Q. Through the hidden eye?

A. Yes.

Q. Now explain why.

A. No, sir; I think I am mistaken. If the slag exit is open, it can't enter then; the furnace will discharge all the slag, and then it will come to a standstill.

Q. What do you say about that furnace producing clean metal when operated according to that model?

A. With the eye open?

Q. Operated according to that model.

A. Well, if you leave any exit for the slag in the level of the forehearth, whether it be on the side or back, the furnace will
252 cease to operate.

Q. Supposing you have put in pure metal before?

A. It will stay there, and if you commence to put on your blast the blast will blow out through the slag hole, and it would not operate.

Q. If you construct a furnace according to that plate and model, and then proceed to operate it, now, like that plate and model, how will you obtain clean metal from that furnace?

A. Well, as I said before, you can't operate it; it will be at rest. The blast will come out in front; nobody will stay there to work it; it will not smelt.

Q. It would freeze up, so to speak?

A. Yes.

Q. Then, if you close up that eye or slag tap from here, how will the clean metal, according to that model and that plate, be produced from that furnace?

A. By a tap from the hearth into the basin.

Q. Do as the defendants say they have done, construct this furnace not according to Karsten, leave this forehearth basin, put nothing but the inner hearth, shut up that eye, make a slag exit, then from the proportions, construction of that furnace, will you nevertheless, on account of the relative proportions of that inner

sump and outer sump called forehearth, get other molten masses, speiss, slag, or matte, into that forehearth?

A. It must.

Q. Have you examined and read the specifications in the plaintiffs' patent?

A. I have.

Q. Have you read the lines on page 166, volume 5, of Mr. Karsten; also on page- 318–320, volume 3, and do you know
253 what it says? Examine it and see.

A. Yes, sir; I have.

Q. Will a furnace, including the mode of withdrawing the clean metal from it, constructed according to those specifications, and then one constructed according to the description in those books, be the same at all in its practical results, with reference to the withdrawal of clean metal?

A. No, sir; it cannot be.

Q. Could you, as a practical smelter, who have built and constructed many furnaces and operated them, take Mr. Karsten's description introduced here, and that plate, and leave of this tap hearth and bason, and then can you withdraw from that furnace clean molten metal, unmixed with slag, speiss, and matte?

A. No, sir; I would have to invent a mode.

Q. If you had nothing to guide you, except those books and that plate?

A. Yes, sir.

Cross-examined:

[Q.] What would be necessary to invent, in order to make this furnace, as described by Karsten, give you clean metal?

A. I know from my own experience.

Q. I want to know what you say the invention would be necessary to be adopted to get these results in the Karsten furnace, as described by him?

A. Well, I have been asked the question, whether the clean metal could be withdrawn from a furnace according to this drawing without the tap hearth, which was in use. A. I don't see how it can be done.

Q. You said, to Judge Symes's last questions, you would have to invent a way?

A. Certainly.

254 Q. I ask you just what you would do to reach that result as a practical smelter?

Ans. I would ladle it out as it comes, if I didn't know of any other way, of course.

Q. If you increased the height of this forehearth the distance between the crucible, raised the slag eye, you would reach that result, would you; the result of getting clean metal into the lead basin from the crucible, without the intermixture of slag from below; would you or not?

A. Yes; if the tuyeres were at a suitable elevation above it, it will, of course.

Q. The principle of hydrostatic pressure is given there; the communicating channel is given there in Karsten, is it?

A. Certainly.

Q. The lead-well is given there—the outside lead-well, or forehearth?

A. Yes, sir.

Q. The slag eye for the exit of slag—the only mistake is they are too low?

A. Too low.

Q. That is all? And the only fault in Karsten's furnace, as described by him, is that there is not sufficient lead in the crucible, nor height in the slag eye?

Ans. Yes, sir.

Q. That is all.

255 The plaintiffs then called as a witness in rebuttal Mr. A. HARTWIG, who, being duly sworn, testified as follows:

Q. Examine pages one to three, also the few lines on page 166, also plate 41, figure 860. Have you examined each one, and have you examined each one of the figures representing all portions of the furnace, and have you examined this model?

A. I have.

Q. State whether that furnace is according to the scale, and, from your examination, constructed in all its essential details and requirements for smelting in exact accordance with the Karsten description.

A. It is a correct copy of drawing 860.

Q. Have you also seen this model produced here by defendants?

A. I have seen it before; yes, sir.

Q. What essential difference, as to the material portion of the furnace, with reference to withdrawing molten metal, is there between the model presented by defendants and the model presented by plaintiffs, the tap hearth in this and the basin in the others. Have you read the specifications in the plaintiffs' patent?

A. Yes, sir; I have.

Q. Are you familiar with them?

A. I am.

Q. Have you read carefully the portions of Karsten's Metallurgy I have referred to?

A. I did, sir.

Q. State if, as a practical smelter who has constructed a large number of furnaces and operated them, you should construct and operate a furnace according to Karsten's description and method, and according to the Keys & Arents method, so far as withdrawing molten metal from the furnace, would the method or the result be at all the same?

256 A. Not at all.

Q. Will you point out as concisely as possible the difference between the furnace and the method, the result of withdrawing clean metal from it, constructed from the Karsten model and description and the Keys and Arents specification patent?

A. In this model the slag has to enter through the lower eye undoubtedly into the forehearth, because the difference between the lower part of the hearth and the hidden eye is three inches, brasque partition only seven and one-half, crucible in front of the furnace being ten and one-half or eleven inches, the slag must enter the forehearth.

Q. If you should construct it with a tap hearth and basin complete, different from this model, what would then be the difference if the slag hole is left open?

A. If you construct the furnace according to Karsten and not according to this model, and attach to it, as required by that plate in Karsten, the tap hearth, what would then be the difference in the mode of withdrawing clean metal from the furnace constructed according to Karsten and according to plaintiffs' specification?

A. The tap hearth, as it is, could produce clean metal, provided the furnace can work.

Q. Supposing it did work, can you construct a furnace according to the method described in Karsten, either in volume 3 or volume V, plate 41, or any other plate in Karsten, and make it accomplish the same purpose and produce the same results as a furnace constructed according to the Keys and Arents patent?

A. No, I could not.

257 Q. You would have to modify it in material parts to do so?

A. Yes, sir; construct it of quite different dimensions and different elevations.

Q. Do you think any practical smelter who has never seen Keys' and Arents' lead-well or plaintiffs' specifications on data — take Mr. Karsten's description and construct a furnace that would produce the same result, with reference to withdrawing clean metal?

A. He could not construct a Keys & Arents furnace out of Mr. Karsten's description.

Q. Would it be necessary to use inventive genius and make material changes?

A. Yes, sir.

Cross-examined:

Q. Do you know what inventive genius is?

A. Yes, sir; I do.

Q. What is it?

A. It is constructing a different improvement by experiments on those before—finding out by practical experience.

Q. Placing that slag eye a little lower or a little lower?

A. That would be inventive genius.

Q. If a carpenter finds a door knob hits his hand and changes it to avoid this, that is inventive genius?

A. That is not inventive genius.

Q. You say by the description given in Karsten, figure 860, the furnace would produce clean metal, but that the slag would flow through the covered eye?

A. Yes, that is what I said.

Q. And that is because the pressure of the superincumbent slag

is so great as to force the lead out from the crucible and through the covered eye?

A. Into the forehearth, yes, sir.

Q. You say the depth of the lead in Karsten's crucible as he describes it is not to exceed seven and one-half?

258 A. The brasque is seven and one-half, hidden eye three inches, crucible ten and one-half, elevation of the tuyere thirteen and one-half; consequently it has to come out.

Q. What I am trying to get at is this, the depth of the lead between the roof of the covered eye and the floor of the slag eye?

A. That is ten and one-half.

Q. That would support three times the amount of slag, thirty inches, then, in that case?

Q. With this slag eye closed so as to dip it, how often would he have to dip it to keep the slag from forcing the lead out?

A. That would depend on the start; in the first place, very little lead after the blast is put on, the forehearth here being ten inches and a half deep, the slag spot being there at the same time with about an inch and a half or two inches, only eigh- inche- and a half, the pressure taken off so much will leave thirteen to eighteen inches of slag to drive out the lead.

Q. Suppose the man working at the smelter taps this slag off?

A. He could not tap it from the start, because he would not have any.

Q. How long would it be before the slag would form?

A. Probably half an hour.

Q. How often would you have to tap it out?

A. Very often; maybe every three minutes.

Q. In a furnace of this size would have to tap it every three or four minutes to keep the stag from forcing a bath of lead four to five inches deep?

A. Yes; it would not be practicable, it would be impossible.

Q. That would be obviated by raising the forehearth, deepening the crucible, and raising the slag eye and the tuyeres?

259 A. If you raise the slag eye and leave it open it would produce the same result, if you raise the slag eye sufficiently high enough and make crucible deep.

Q. How deep would it have to be?

A. Twenty-four to forty inches.

Q. What is the depth of an ordinary crucible to-day?

A. Thirty-six to forty inches.

Q. By deepening that crucible, raising the slag eye, and deepening the lead basin, all this is obviated, is it not?

A. It would be, yes.

Q. Even by leaving this as it is and allowing the slag to flow out over here over the lead basin, you could well get clean lead and tap it out through here?

A. Then it would get clean lead, yes.

Q. Are you engaged in smelting at the present time?

A. No.

Q. Are Keyes and Arents going to give you a job?

A. No, sir; I never asked any.
Q. What furnace were you engaged at last?
A. Socorro, New Mexico.
Q. You used the Kyes and Arents attachment?
A. Yes, sir.
Q. You may state whether or not in the Kyes and Arents attachment they have a hole in the lead basin an inch or two below here, where the lead trickles out?
A. It might; sometimes I do it myself. The difference is to receive cool lead.
Q. How much cooler?
A. It is considerably cooler, a number of degrees; I don't know—entirely left to the superintendent. He has no object for it getting loocer.
Q. They add a tap to it here, somewhere?
A. Yes, sir.
Q. Now, then, it is substantially the same process?
A. This is tap-ed with the object of clean lead; this is done only to get cool lead.
Q. Can you distinguish between an act and an object, and motive of an act; do you know the difference between an act and
260 the motive of an act?
A. Yes.
Q. Then please answer the question, whether the physica- act of dipping it out of Keys and Arents lead-well, somewhere here, is the same physical act a- tapping it out here?
A. It is not at all.
Q. All right; you may go.

Re-examined:

Q. After the metalreaches the Keys and Arents basin the lead is then separated?
A. Certainly it is.
Q. Then you can carry it away in a ladle or put a tap in that basin or do as you please with it; the separation of the metal is complete, and it is then ready for market?
A. It is.
Q. In this case the operation of the tap from the forehearth is to get out the metal from other masses?
A. That is the main object.
Q. In the other case you have it separated form the other mass?
(No answer.)

261 The said plaintiffs called as a witness in rebuttal Professor Milton Moss, who had been duly sworn, & who testified as follows:

Q. Are you familiar with the specifications of the plaintiffs' pa-nt?
A. I am, sir.
Q. You have studied them?
A. I have.
Q. Are you familiar with pages 318 to 320, Volume III, of Mr.

Karsten's Metallurgy, and the short description on page 166 of the fifth volume, and plate or table 41, figure 860, and the other figures adjoining, representing the whole of a smelting furnace supposed to have been practically operated?

A. Yes, sir.

Q. State whether or not, from your examination of this model, produced here by the plaintiff, it is a complete model in all essential details and particulars of the furnace represented by figure 860 in Karsten.

A. Yes, sir.

Q. That is, a correct model of it?

A. As near as I can judge.

Q. Have you examimed the model before?

A. Yes; I have.

Q. Have you examined the atlas before, and the figures, and taken the scale of them?

A. I am quite familiar with them.

Q. Have you seen, and examined from its use upon this trial, the model introduced here by the defendants, called the model of the Karsten furnace?

A. I am not familiar with this model.

Q. Would a furnace constructed according to that model be according to the description in Karsten, and the plate, and figure 860, and others?

A. It is not according to the description or the drawing given in Karsten as far as I can see. The slag is tapped here to one side, and not from the forehearth.

262 Q. What essential portion of the Karsten furnace is left out entirely?

A. And again, it is not complete in not having the tap basin attached to it, as it is in figure 860, and it does not contain the tap basin as given here.

Q. If a furnace is constructed according to that plate and that model, and the descriptions in the portions of Karsten's works that I have referred to, would its arrangements or its practical results in smelting, with reference to the withdrawing of clean metal from the furnace when in operation, be the same as a furnace constructed according to the specifications of the plaintiffs' patent?

A. It would not; no, sir.

Q. If you should, without the aid of the plaintiffs' specifi[cations] or patent, or without ever having seen in operation or heard described, orally or otherwise, a Keys and Arents lead-well, could you take that atlas and Karsten's works and construct a furnace that would produce the same practical and useful results as a furnace constructed according to plaintiffs' specifications?

A. No, sir; it would be absolutely impossible to produce the same practical results with reference to the withdrawing of clean metal; that is the difference.

Cross-examined:

Q. Is this thing here any part of a furnace; I mean by this thing the tap basin?

A. Well, you would have to tap the lead; unless you had a receptacle to receive it into, the lead would flow all over the floor of the establishment.

263 Q. I ask you the question whether the tap basin into which the lead in the Karsten furnace, as he describes it, is any part of the furnace?

A. As long as it is described as a part of the furnace it is a part of the furnace? *A.* Yes, sir; if Karsten had not described it it would not have been.

Q. I ask you if a slag pot is not part of a furnace, or a portion of the paraphernalia of a furnace, or of anything—is any part of a thing itself?

A. Well, it may not be in substance; if it belongs to a thing it is part of the thing.

Q. I want to know whether you consider the slag pots you use in your furnaces as a part of the furnace?

A. It belongs to the furnace—that is, belongs to the instruments of the furnace; yes, sir.

Q. A smelter and the workmen about a furnace are necessary to the ordinary operation of smelting?

[A.] The persons who work around a furnace are necessary to its successful operation.

Q. Are they not a part of the furnace as long as they are connected with the furnace?

A. I consider they are in a measure; they are a part of the working of the furnace, a part of the establishment.

Q. Karsten did not describe any persons working around his smelter. Does he describe any persons about that furnace as bieng about the furnace?

A. I presume the furnaces would not run of their own accord.

Q. Does he describe any person there about the furnace?

Answ. Well, I don't think he does.

Q. What is it that prevents this from working and producing clean lead in this basin in the Karsten furnace, as he describes it at page 166, figure 860?

264 A. I said it would not produce the same practical results in the withdrawal of clean metal that is obtained by means of the Keys and Arents.

Q. Is the difference between the practical results of the Arents and Keys attachment and the Karsten furnace one of quantity or one of kind?

A. If you would allow one to explain the difference between the Keys and Arents furnace and that cut, is this——

Q. Don't tell me. Is the difference between the practical results of the Karsten furnace and the Keys and Arents one of quantity or one of kind?

A. What do you mean by quantity? No, certainly; the furnace is different; the construction and combination is very materially different in the two furnaces. I don't know just what you have reference to—I wish you would allow me to explain what I imagine——

We will waive that, waive an answer.

Q. A furnace constructed upon the description of Karsten will produce into this forehearth or lead-well clean metal, would it?

A. If that furnace is worked to accomplish the results whenever it can (? cannot) be worked to accomplish the same results that can be accomplished by means of the Arents and Keys tap.

Q. Can a furnace constructed upon the description and plate 860, given by Karsten, be so worked as to produce from the inner crucible to the outer lead basin pure metal, clean metal?

A. No, sir; it cannot.

Q. That is because the weight of the superincumbent slag is too great for the mass of lead below it?

A. Allow me to qualify there; if I recollect rightly this furnace, as described here in Karsten, 858, 859, 860, the lower portion of
265 that furnace was not closed up, as described here, but there was another closing furnace, or rather the lower portion of the furnace was constructed differently, as he indicated in his book in the figures 473.

Q. I don't want anything to do with 473. Stick to the question.

A. You say why that wasn't exactly like that. I don't recollect whether it was closed or an open-breasted furnace; anyhow, the lower portion of this furnace, as given here, wasn't used as he said; if it were used then it could produce practically clean metal.

Q. On account of the weight of the slag above?

A. It is dependant upon the relative proportions of the furnace.

Q. At page 166 of volume 5 he gives the dimensions of the furnace above the crucible, don't he?

A. Yes, sir; that is correct; but he does not give the dimensions of the crucible at all. He refers to the crucible of another furnace. He does not give any dimensions here of a crucible; only gives the dimensions of the furnace above the crucible.

Q. What right have you to believe it is a crucible of certain dimensions? The figures here, it refers to certain figures. These are all drawn according to measure.

A. If you want to construct a furnace according to these figures, they are, I presume, given correct.

Q. That is the reason there is too much slag above it to work?

A. The dimensions of the furnace would enable us to say whether clean metal would be withdrawn or not.

Q. Have you ever built a furnace after that model to test it?

A. I never have; no, sir.

Q. You have never seen one that was built after that model?
266 A. No, sir.

Q. I will ask you—you heard Mr. Grant and these other witnesses testify as to that, did you?

A. I did.

Q. You think they are all mistaken about this being an exact representation of that figure?

A. I never measured that figure; I could not say.

Q. When lead runs into this forehearth into the Karsten furnace, is drawn from this forehearth into the lead basin, it so runs in the same way upon the same principle, upon the same physical law,

that it runs out of the Keys and Arents well, when that is pierced at one side?

A. Mr. MACON: The principle is undoubtedly the same; we don't deny that; there is a vast difference in the effects, results. If you will allow me, here we have an ascending tube.

Q. Does it make any difference in the Keys and Arents attachment whether the channel runs out horizontally, at right angles, or in a slant?

A. It makes a difference; it is far more convenient. It does not make any difference in the principle.

Q. Does it make any difference in the application of the principle of the Keys and Arents whether the lead basin is on the bottom of the crucible, or whether the lead basin is at the side—extends down?

A. It would make no difference in principle, but the effects.

Q. The effects differ?

A. The principle remains the same.

Q. Whether it is raised above or below the bottom of the crucible, in the Keys and Arents attachment, is a matter of taste with the smelter, or of judgment?

A. I beg your pardon. He says the basin must be of suitable proportions, laying at suitable elevations above the bottom of the furnace.

267 Q. Suitable elevation above the bottom of the furnace leaves the smelter the option or choise to set it as high or low as he wishes?

A. It says suitable proportions. Every smelter who has had any experience in smelting would know how high to place that to suit the furnace.

Q. Did you hear Mr. Geist say his were on a level with the bottom, this great smelter?

A. Well, that is immaterial.

Q. Did you hear Mr. Geist testify——

A. I don't recollect.

Q. That his basin had a straight channel, and were on a level with the bottom of his furnace or crucible?

A. I don't recollect that I did.

268 The plaintiffs then called as a witness in rebuttal WINFIELD SCOTT KEYS, who had been duly sworn, and who testified as follows:

Q. What time did Mr. Grant, the defendant, make that payment to you and Mr. Arents of the license?

A. He made it to Mr. Arents on the 12th or 13th of September, 1880.

Q. When did you leave Leadville, and when did you cease to have the management and control of the Chrysolite, Iron, and any other mines?

A. On the 12th day of August, 1880, I left, for good reason, all my charges in Leadvillle.

Q. Are you or not familiar with pages 318 and 320 of the third volume of Karsten's Metallurgy, and the short description on page 166 of the fifth volume; also with the figure 860, and other figures representng different portions of the same furnace, in table 41, Karsten's Atlas?

A. I am.

Q. You are one of the inventors and discoverers of this device or process, called the Keys and Arents lead-well for withdrawing the clean metal from the bottom of the furnace?

A. I am.

Q. State whether the description in Karsten's volumes and the atlas, taken separately or taken altogether, in connection with such description, will enable a practical or theoretical smelter or metallurgist to construct a furnace that will produce the same result as your device and invention, with reference to withdrawing clean metal from the furnace when in operation.

Objection. I would like to know whether the result means difference in quantity, degree, or difference in kind.

269 Judge SYMES, of plaintiffs' counsel: It means a difference in the kind of metal produced, and the method by which it is produced, as to whether it is clean or mixed.

A. In my judgment it cannot be made to produce the same result in the same manner from both. Clean lead is produced in the one by a tap through the descending channel; in the other, by means of a basin connected with the ascending channel.

Q. Can a practical smelter and metallurgist construct a furnace from your specifications, following them, which will be like, in its operation or practical result, in its method or practical result, of that of Mr. Karsten, obtaining clean metal when in operation? In other words, if you build a furnace according to the specifications, will it produce the same result as the one described by Karsten?

A. By our combination and arrangement we produce clean lead; following the prescription or direction of the model of the figure in Karsten you will not produce clean lead in the forehearth.

Q. Have you examined the model presented by Mr. Arents?

A. I have.

Q. Does that model correctly represent it according to the scale in figure 860, plate 41, of Karsten's Atlas, and the descriptions in his work mentioned?

A. It does.

Q. Have you examined this model introduced here in illustration by defendants, and about which so much has been said?

A. I have.

Q. Explain to the jury the difference between the model introduced by the defendants and the model introduced by the
270 plaintiffs, with reference to any essential particulars that may exist in the art of smelting.

A. In general terms, this model introduced by the plaintiffs is complete; in general terms, the model introduced by the defend-

ants is incomplete; certain portions, adjuncts, appendages of the furnace, of and to the furnace, are not represented on this model. The principal one is the tap hearth for the lead and the tap canal leading to it, which is dotted on plate 41, figure- 853, 832; 858 is the ground plan; 860, same furnace, the brasque partition beneath in the working door of the furnace, is approximately correct. It is a matter of eyesight, and the figures here are very small. I have measured these several times, and the brasque partition, the removable partition, is two and one-half times the size of the lower connection. In this model, I think, it is not quite the same. There is not much difference, no essential difference.

Q. This brasque partition has been spoken of here, and we have all spoken of it as if it were a solid, fixed, immovable partition?

Objected to as immaterial. Objection overruled.

A. It is not such; that is precisely the difference; it has an effect—in the first place, this furnace, according to the description of Karsten, was never intended to smelt ore, with this construction, with this method of closing. Furnaces in the books are named according to the *lumachen*, the closing and filling into and finishing the bottom principally in the region of the front or working door. When the
271 brasque extends deep down, without a hole up above it, it is then called a closed breast. If it have an open breast, the front wall artificially prolonged in front extends down in a greater or less degree into the molten metals. When it is intended to smelt ore in a furnace of this description, it is plainly and distinctly stated that it is *lugemacht*, closed, made up, after the manner of the furnace, with an open breast. When we speak of smelting ores, Prof. Karsten says distinctly that that is the method of closing it. This brasque partition—I will assume now that ore may be smelted in such a furnace—this brasque partition is in front and underneath the working door of the furnace, part of the working door. It is always necessary to put a bar into the furnace to see how the furnace is running, to feel the bottom, to see if any accretions are going on there, to see if it is all smo-the, if it is open, as if it were water. The first time the bar comes in there it destroys, in a greater or less degree, this brasque partition. After going in there a number of times it absolutely destroys it. That is the reason why, in the smelting of ores, that is indefinitely prolonged. It was practically impossible. We have always assumed that that remained hard, fixed, and firm, which was not the case in actual operation, even if it did approximate; if ore was smelted in such a construction, according to physical laws, and the working results, matte and sp-ice would cer-
272 tainly come under, and under certain conditions slag also. If either went under, the lead would not be pure.

Q. What is this brasque partition, extending down, used for?

A. Revivifying litharge, bringing it up into a metal-ic state. The oxide of lead produced on the expellation of litharge contains 93 per cent. of lead. If it were absolutely pure there would be nothing but lead in the furnace; but since no litharge is perfectly pure, and since the litharge has a great eating, corroding tendency, eating out

these furnaces are built of stone. A furnace made in that way, the slag would flow—under these conditions—underneath the fire wall, because it is the heaviest slag that is made or produced. In litharge smelting frequently as high as 30 per cent. of metallic lead.

Q. In the way these Karsten furnaces were used, from your knowledge of smelting, state how often in the practical operation of the furnace, this brasque partition was taken out and replaced.

A. According to my reading and understanding, once at least in twelve hours. On page 225 of Volume V, the ninth line from the top, and 10, 11, and part of 12, Karsten states: "In the Hartz, it is customary to reduce litharge in the low shaft furnace, which is the name of this furnace which is used for smelting mattes, and charcoal is used." This is the purpose for which this furnace was used. At page 166, in immediate connection with figures 858 to 860, he says: "The method of closing this furnace is *is* the same as
273 that of a high furnace." These are called low furnaces, the same as that high furnace.

Q. Anything more you wish to read?

A. On page 320 of Volume III, the last sentence from the bottom: "In these smelting operations in which a small quantity of slag only is produced the upper eye or open-eye is wanting, and the slag must pass through the closed eye *ebenfals*" (that means just as much) "into the forehearth."

Q. Will a furnace, constructed according to the model introduced here by the defendants, when operated, produce clean metal in any basin or part of it, separated from all speiss, slag, and matte?

A. Not until you tap it out.

Q. To tap it out and get clean metal from such a furnace as this of the defendants' model represents when in operation, what essential changes or additions would you have to make?

A. In the first place, to get out clean metal, as the model is constructed, you must tap it. In the second place, to get at it without tapping, you must entirely remodel the front of the furnace, make additions, alterations, and changes.

Q. Are they material additions and changes in the art of smelting?

A. They are, very. A mechanic who is accustomed to it can understand the change of the relative position of the parts. Mechanism may destroy, alter or change. For instance, if the piston rod of an engine be too long, it won't work at all; it must be exactly right, and that must be in proportion to the balance of the engine. The same thing is true in reference to this furnace—the part
274 must be in proportion to obtain certain results. When these proportions vary, other results are obtained; and in order to obtain like results within limits, they must be the same. By that I mean that if this connection with the bottom of the furnace extends upwards to and outside of the basin, clean lead will be obtained; if it be a few inches higher, clean lead, likewise, will be obtained. A point will be reached, finally, in the progress of smelting, when that result takes place no longer. That is what I mean when I say it must be within limits.

Q. Can you, on any other experienced smelter, take plate 860, table 41, and construct a furnace that will produce clean metal separate from all slag, speiss, and matte, unless it be tapped off by an old hearth?

A. I don't think he can.

Q. Would it require experiments and changes to produce it, in addition to what is represented in those books?

A. It would require material alterations, emendations.

Q. When you say in your specifications that a tap and basin of suitable dimensions are used, attached to an ordinary furnace at a suitable elevation above the bottom of the furnace, you mean that suitable means within the limits required by the size of the furnace, the depth of the crucible, the thickness of the walls, etc. Q. You would change that basin, and locate it so many inches above the bottom of the crucible, according to the depth of the crucible of the furnace you was putting it to?

A. Yes, sir; and its relation to the breast and the tuyeres.

275 These are matters alwa-s to be taken into consideration in making up, as it is generally called, the bottom of the furnace.

Q. But in the Karsten furnace, to obtain the best results, it must not run out horizontally into an adjoining basin on the same horizontal level?

A. To obtain the best results it should be inclined.

Cross-examined:

Q. When did you make this demand upon Mr. Grant of the license?

A. Never made it personally at all; turned it over to Mr. Arents.

Q. Do you know when it was made, except so far as the time payment was made—you don't know how long before that Mr. Arents made the demand?

A. It was made before my departure from Leadville, and the payment was made one month after my departure.

Q. Had you any talk with Mr. Grant before your departure from Leadville?

A. I have no recollection; Mr. Arents did; I have no recollection, Judge; possibly may; should not be surprised if I had.

Q. You say to get the best results from your attachment and invention it is necessary that the lead-well should be set higher and the tap should be inclined and not horizontal; wouldn't that make the lead-well higher?

A. Oh, yes; it must be higher.

Q. You heard Mr. Geist's testimony, didn't you?

A. I did.

Q. You heard him say his crucibles were connected with his lead-wells by a straight channel?

A. No, sir; he said not connected from the bottom, certain number; in my judgment that is the reason why he says it was possible to get slag into them, they were located too high; that explains it.

276 Q. You certainly did not fail to understand him when he

said that the first two with the Keys and Arents attachment were from the bottom, and on a slant, and he afterwards changed them to straight ones?

A. I think he said something of that kind.

Q. It is your understanding that Mr. Geist did not say he tapped from the bottom, but with these straight channels into the lead basin outside?

A. I understood he said he did have at one time on the bottom; my recollection is he said he concluded it was better to have it higher up.

Q. Suppose it to be true that the defendants tap from the bottom, with a straight channel into an outside lead basin from which the lead rises practically to a level in the lead basin with the lead in the crucible, is he using your device or not?

A. With an elbow, the level of the lead higher up, he is using an inferior device.

Q. It is your device?

A. I contend it is.

Q. From your understand- of the specifications, mechanics, and metallurgy, he is using your patent?

A. He is using an inferior variety; yes, sir.

Q. When Karsten gave the description of a furnace with a straight channel running into a lead basin on a level with the bottom of the crucible through which the lead flowed and rose practically to a level with the lead in the crucible, is he using a modified form of your invention?

A. He is not.

Q. Why not?

A. Because his forehearth is the receptacle, and so intended, for all the products of combustion except the gas, and it has a
277 chamber not merely for their reception but for the separation by gravity. When ore is smelted, judging from the statements of experts on the stand here, one would think the lead came down by itself, the speiss and matte came down by itself, and the slag came down by itself; whereas, as a matter of fact, they first become warm, the water is drawn off, finally get fluid, finally separate the slag; the matte must be so that the particles, the shots, the reduced lead, can sink through it. It comes down as a mush, then becomes fluid, falls down and separates partly in the front in the forehearth. The object of the forehearth is a quiet and still place, a still haven, *fore-bay*, to enable gravity to work and to settle it; the object of our basin comes in after all this is done.

Q. The truth is, the slag liquifies first?

A. Here is no slag. If you add slag——

Q. In smelting operations, you make slag before you make any other liquid product?

Ans. Oh, no.

Q. What is the first liquid product you make in smelting?

A. Lead ore. In the shaft furnaces, the *the* matters put into them are generally oxides or carbonates; the first thing, the carbon in the carbonates is driven off, the second operation they commence to cin-

der together, the whole mass cinders, and then in this heated state the reducing gases reduce the oxides to metals, part of the oxides are taken up by the fluxes, either added or which are in the ore, and then the slag is first formed; the slag is formed after the reduction, and by reduction I mean withdrawal of the oxides in
278 combination with the metal-ic substances; the metal is formed and the cindered matters become what is called true slag; in other words, they combine.

Q. You have said the furnace as described by Karsten, in his book, and plate 860, will not produce clean metal in the forehearth, so that it can be ladled out clean?

A. I believe it is entirely impossible.

Q. You testified in this other case, or in the first trial of this case last spring?

Ans. I did.

Q. And were examined as to Karsten's works, and Karsten's plates, and the models produced?

A. As to a certain model produced here.

Q. Which was the model of a furnace worked by the Governor-elect in these experiments?

Ans. It was so stated; I understood it to be so stated.

Q. In that examination you did say that the Karsten furnace, as described in Karsten, was a modified Keys and Arents furnace, if you only removed the slag tap to one side, didn't you?

A. I can't remember; I would say now that that would approach it.

Q. I will read. Was this question put to you by the court: "If the old forehearth were carried up in form of a wall to a level with the lead in the crucible, what would be the difference between the old and the new method?"

A. "There would be none if the slag were allowed to run off in some other way; but by our device, the forehearth being raised to a level with the lead in the crucible, and the slag being drawn off through a slag eye, constitutes the difference between the old and the new method. We deny that the process was ever used
279 before our invention."

Q. Did you say that?

[A.] That is rather unintelligible.

Q. Second question by the COURT: "I will ask you whether the principle of liquids seeking the same level, which is partially applied in the Karsten, has ever been applied, except in the new method of Keys and Arents?"

"A. I doubt if it has ever been employed; I do not know if it has ever been, though with slight changes it can be made into our device, etc."

A. It sounds familiar; I don't know.

"Q. Suppose you take the Karsten furnace and close up the slag hole, or arrange so that nothing but clear metal alone can come into the Karsten forehearth?"

"A. It would be a modified Karsten furnace, and not a Karsten furnace as described in the book."

Answer. That is true; I don't remember whether I stated it so; but it is true.

Q. Now here comes the cross-examination: "You say the principle upon which the Karsten furnace acts—the principle of communicating vessels—is the same as this of Keys and Arents?"

"A. Exactly."

"Q. The metal ran into this outer well to the same level that it ran into the crucible?

"A. Yes.

"Q. Through this eye?

"A. Yes.

"Q. The front wall came down to the bottom of the crucible?

"A. No, sir; that was an artificial prolongation made of brass.

"Q. There was a wall which came down to separate the crucible into two vessels instead of one; through that there was an eye made to serve as a communication between the two vessels?

"A. Yes.

280 "Q. The metal flowed through this eye, and rose to an equal height in the basin?

"A. Yes, sir.

"Q. That was hydrostatic pressure?

"A. Yes.

"Q. The slag flowed through the slag eye above the lead basin, if there was enough lead in the crucible to cover this eye?

"A. No; not until the lower eye was covered with matte; after the lower eye was covered, it run through the slag eye.

"[Q.] From there the slag flowed through the lower eye or not, depending upon whether they put in enough metal to produce lead sufficient to cover the lower eye before any slag was formed?

"A. Essentially, it did.

"Q. But whether or not the slag did flow through this lower eye depended upon the choice of the man who smelted it?

"A. Yes.

"Q. Was there principle involved in that?

"A. Properly speaking, there was not.

"Q. If Karsten had seen fit to make the slag eye on the side of the furnace, instead of it being in front, would he not have had your invention? You say he would not; what is the difference?

"A. He would have had a modified form if he had made the brasque of imperishable material, removed the slag eye, and put it around to the side; he would have a modified Keys and Arents furnace."

Answer. I say that to-day.

"Q. When a furnace is constructed as this Karsten furnace is, with a tap attached to this slag eye, so as to conduct the slag away, would the lead-well on this furnace act badly?

"A. No.

"Q. Would it act as this of yours, so long as this lower eye was kept open?

"A. Yes; most assuredly.

"Answer. If the lower eye was kept open.

"Q. You applied for a patent?

"A. Yes, sir.

281 "Q. The only thing new is the slant?

"A. If there be anything new, any part or portion of it which is absolutely new, it is the slant."

[Q.] Did you say that—stand by that?

Ans. Of course.

Q. Do you remember these answers and questions?

A. I don't remember distinctly.

Q. Do you say you do that?

A. I do not—the slag hole was entirely different here.

Q. Anything else?

A. The condition of the parts.

Mr. KEYS: The Governor-elect stated that Mr. Percy stated our invention was a fraud. I want to resent the implication.

Witness reads from Percy's work on page 549, "The Syphon or Automatic Tap," in a paper read at the American Institute of Mining Engineers of 1871:

"What is, generally, a large furnace that is placed —— has two tap holes —— one tap is placed —— Mr. Arents, of Eureka, consolidated —— and his efforts have been crowned with such success ——

282 it consists of a sheet iron cylindrical —— channel, outflow of regulus therefrom —— that it is profitable proved by actual work."

Mr. MACON, of defendants' counsel, objects to the reading of the whole article.

THE COURT: We will suspend it here; it is a matter of no importance anyway.

283 Counsel for plaintiffs then requested the court, among other things, to instruct the jury as follows, to wit:

The defendants claim that the said discovery or invention, called a lead-well or automatic tap, and a particular description thereof had been, before the issuing of the said patent, particularly described in a certain work upon metallurgy and smelting furnaces in Germany, in Europe, and other places, by Prof. Karsten, as alleged in the answer of said defendants, and the jury are instructed that before the defendants can defeat the plaintiffs' patent on such ground of prior publication they must find and believe, from the evidence, that the description of the invention or mechanical device or process in such books or foreign publications were so full and complete and so much like plaintiffs' lead-well or automatic tap, as described in the specifications to plaintiffs' patent, that any artizen practically skilled in the art of constructing and operating smelting furnaces could without any other aid, except from the reading of such books alone, construct and operate the said lead-well or automatic tap. That is, the jury should be satisfied that the said plaintiffs acquired their knowledge and obtained their invention or mechanical device from reading and knowing said foreign publications, and not as a result of invention or discovery of their own minds.

284 But the court refused to give said instruction; to which decision of the court, in refusing to give the same, plaintiffs, by their counsel, then and there duly excepted.

285 Counsel for plaintiffs then requested the court, among other things, to instruct the jury as follows, to wit:

The jury are instructed that the particular portion of the so-called Karsten furnace called the forehearth, which is claimed by defendants to be the same as plaintiffs' automatic tap, in order to defeat the plaintiffs' patent, it must have been described in the said Karsten books to be used for the same purpose and for the same object as the plaintiffs' automatic tap and must have practically accomplished the same result; and unless the jury so believe, the said description of a Karsten furnace in the said books cannot defeat plaintiffs' right to recover.

But the court refused to give said instruction; to which decision of the court, in refusing to give the same, plaintiffs, by their counsel, then and there duly excepted.

286 Counsel for plaintiffs then requested the court, among other things, to instruct the jury as follows, to wit:

If the jury believe, from the evidence, that the principle that liquids in communicating vessels seek the same level has not been before applied to the purpose of drawing off clean metal from smelting furnaces, when in operation by the same device or mechanical contrivance described in the plaintiffs' specifications to their patent, and has not been practically, fully, and completely described in the foreign publications or works relied on by defendants, they will find for the plaintiffs.

But the court refused to give said instructions; to which decision of the court, in refusing to give the same, plaintiffs, by their counsel, then and there duly excepted.

287 Counsel for plaintiffs then requested the court, among other things, to instruct the jury as follows, to wit:

The jury are instructed that before they can find that the plaintiffs' invention or automatic tap has been fully and completely described in foreign publications, so as to defeat the patent, they must find from the evidence that the process, contrivances described in the said foreign publications must be for the same purpose of withdrawing clean molten metal, separated from all other substances, from smelting furnaces, on the principle that liquids seek the same level in connecting vessels, in substantially the same way that it is done by the plaintiffs' lead-well.

But the court refused to give said instructions; to which decision of the court, in refusing to give the same, plaintiffs, by their counsel, then and there duly excepted.

288 Counsel for plaintiffs then requested the court, among other things, to instruct the jury as follows, to wit:

If the jury believe, from the evidence, that the so-called Karsten furnace, or Karsten forehearth, constructed according to the description in Karsten's work or atlas referred to, without any material change, does not or will not withdraw clean molten metal from smelting furnaces while in operation without any mixture of slag, matte, or speiss, then such foreign publications will not defeat plaintiffs' patent or right to recover.

But the court refused to give said instruction; to which decision of the court, in refusing to give the same, plaintiffs, by their counsel, then and there duly excepted.

289 Counsel for plaintiffs then requested the court, among other things, to instruct the jury as follows, to wit:

The jury are instructed that what is a furnace of ordinary construction in 1871, the date of plaintiffs' patent, and the mode of tapping metal from such furnaces, and the position and character of the slag exit, are questions of importance in the construction of such a furnace in considering the process or improvement of the plaintiffs' patent, because it is to such a furnace that the plaintiffs claim to have applied their discovery and improvement.

But the court refused to give said instruction; to which decision of the court, in refusing to give the same, plaintiffs, by their counsel, then and there duly excepted.

290 Counsel for plaintiffs then requested the court, among other things, to instruct the jury as follows, to wit:

The jury are instructed that there seems to be a little or no dispute in this case that the plaintiffs are the owners of the patent right claimed; that the specifications are sufficiently certain in description to enable the discovery and invention to be carried out and operated from them; and that it is useful and beneficial in its results, and an improvement on the old methods of accomplishing the same results; and the princip-le question for the consideration of the jury in this case is, whether the description of a furnace contained in Karsten's Metallurgy, relied on by the defense, is substantially the same in its operation and results as the plaintiffs' patent.

But the court refused to give said instructions; to which decision of the court, in refusing to give the same, plaintiffs, by their counsel, then and there duly excepted.

291 Counsel for plaintiffs then requested the court, among other things, to instruct the jury as follows, to wit:

The jury are instructed that if the said Karsten furnace, constructed substantially according to the description read from the books, will not ac-omplish or bring about the same useful results in the withdrawal and separation of the clean molten metal from the bottom of a crucible of the furnace, as the plaintiffs' lead-well, then such foreign publications cannot defeat the plaintiffs' patent.

But the court refused to give said instruction; to which decision

of the court, in refusing to give the same, plaintiffs, by their counsel, then and there duly excepted.

292 Counsel for plaintiffs then requested the court, among other things, to instruct the jury as follows, to wit:

The jury are instructed that the changes in the mechanical arrangements and proportions of the furnace, however unimportant they may appear, if they produce a useful and beneficial result and a substantial improvement in the art of smelting, such changes, together with the beneficial results obtained, will support the plaintiffs' patent.

But the court refused to give said instruction; to which decision of the court, in refusing to give the same, plaintiffs, by their counsel, then and there duly excepted.

293 Counsel for plaintiffs then requested the court, among other things, to instruct the jury as follows, to wit:

The model presented by the defendants is claimed by them to be like a Karsten furnace, represented in figure 860 of the Karsten Atlas, and described on page 166, volume 5, of Karsten's works, and other figures on the same page of the atlas; and if the jury find, from the evidence, that this model is not like the said figure 860 of said atlas and the description on said page 166 in all the essential and material details, they should not consider it in this case.

But the court refused to give said instruction; to which decision of the court, in refusing to give the same, plaintiffs, by their counsel, then and there duly excepted.

294 Counsel for plaintiffs then requested the court, among other things, to instruct the jury as follows, to wit:

Defendants rely, as a defense, on figure 860, plate 41, in the atlas of Karsten's Metallurgy, and the description found in volume 5, page 166, of Karsten's works; and if the furnace claimed to have been built and operated by the defendants was not substantially the same as this description, and did not without any material changes produce the same results as the plaintiffs' lead-well, they will find for the plaintiffs.

But the court refused to give said instruction; to which decision of the court, in refusing to give the same, plaintiffs, by their counsel, then and there duly excepted.

295 Counsel for plaintiffs then requested the court, among other things, to instruct the jury as follows, to wit:

On this question of prior publication, in relation to it, the court charges you that a description contemplated by the law as sufficient to defeat a patent must be sufficiently full, clear, and concise, so that a person skilled in the art to which the invention appertains could from the description construct the invention of the plaintiffs; and if you find that Karsten does not give such a sufficient description in his work, *of* Fig. 860, as would enable a person skilled

in the art to produce that invention, or sufficient to entitle a party to a patent which would defeat this invention, then you are to consider that that figure 860 does not constitute a defense in this case.

But the court refused to give said instruction; to which decision of the court, in refusing to give the same, plaintiffs, by their counsel, then and there duly excepted.

296 Counsel for plaintiffs then requested *to* court, among other things, to instruct the jury as follows, to wit:

The jury are instructed that they are the judges of whether or not the automatic tap of plaintiffs is like the so-called "Karsten forehearth" in its objects and uses and beneficial results. To determine this, they should consider what changes have to be made in the construction of a Karsten furnace and its operation to make it like the automatic tap; that is, has the open slag eye, so called, been changed into a slag tap hole; has the position of the open eye and slag exit been changed; did the Karsten forehearth receive into it all the molten masses, while the automatic basin receives only clean metal; and was the location of the Karsten forehearth, with reference to the front and sides of the furnace, the same as the automatic tap. Whether these are material changes, and whether these changes produce useful and beneficial results in the method of withdrawing clean metal from furnaces, are questions of fact for the jury; and if the jury believe, from *from* the evidence, that these changes are material and beneficial in their results, they will find for the plaintiffs.

But the court refused to give said instruction; to which decision of the court, in refusing to give the same, plaintiffs, by their counsel, then and there duly excepted.

297 Counsel for plaintiffs then requested the court, among other things, to instruct the jury as follows, to wit:

The jury are instructed that the amount of damages plaintiffs are entitled to recover is the annual license fixed by them for the use of their invention, or automatic tap, which has been testified to be $250.00 a year, in advance, for the use of each automatic tap attached to a furnace. The number of furnaces used by defendants multiplied by 250, and then by the number of years defendants have used such automatic taps, will be the measure of plaintiffs' damages; such fee is charged in advance, and the fractional part of a year must be regarded as a whole year.

But the court refused to give said instruction; to which decision of the court in refusing to give the same, plaintiffs, by their counsel, then and there duly excepted.

298 And thereupon the court charged and instructed the jury, among other things, as follows, to wit:

"Gentlemen, you are directed to find the issues upon the evidence before you for the defendants."

To the giving of which charge and instruction the plaintiffs, by their counsel, then and there duly excepted.

And thereupon the court specially directed and instructed the jury to find a verdict for the defendants.

To which direction of the court, in directing the jury to find a verdict for the defendants without considering the case, the plaintiffs, by their counsel, then and there duly excepted.

And thereupon the court said: "Gentlemen of the jury, we will enter your verdict for the defendants in this case." And thereupon the court did enter in its minutes the verdict of the jury for the defendants; and the jury were thereupon discharged and not sent to their room in charge of an officer to consider of their verdict, but their verdict was entered as above stated by the court.

To which instruction of the court in directing the jury to find a verdict for the said defendants, and also to the action of the court in entering the verdict of the jury for the defendants in the
299 minutes of the court without sending the jury in charge of an officer to their room to consider of their verdict, the plaintiffs, by their counsel, then and there duly excepted.

Thereafter the court directed judgment to be entered of record against the said plaintiffs and in favor of the said defendants upon the said verdict so entered by the court in its minutes.

To which entry of judgment and to the judgment so entered the plaintiffs, by their counsel, then and there duly excepted.

And forasmuch as the matters and things above set forth do not fully appear of record, the said plaintiffs tender this their bill of exceptions, and pray that the same may be signed and sealed by the judge of this court pursuant to the statute in such cases made and provided, which is done accordingly this 7 day of February, A. D. 1883, being one of the judicial days of the term of court, A. D. 1883, at the city of Denver, in said district.

(S'g'd) MOSES HALLETT, [SEAL.]
Dist. Judge.

G. G. SYMES,
ROB'T E. FOOT,
Of Counsel for Pl'ffs.

Endorsed: No. 613. U. S. circuit court, district of Colo. Winfield S. Keyes *et al. vs.* James Grant *et al.* Bill of exceptions of plaintiffs. Tendered Jan. 22, 1883. (S'g'd) Moses Hallett. Filed Feb. 7, 1883. (S'g'd) Edward F. Bishop, clerk.

300 And afterwards, and on, to wit, the 9th day of February, A. D. 1883, came again the said plaintiffs, by their attorneys aforesaid, and filed in said court their bond, and sued out of said

court a writ of error and citation to the Supreme Court of the United States.

And the said bond is in words and figures as follows, to wit:

Bond on Writ of Error.

301 Bond in Appeal or Error, United States Court, Colorado.

THE UNITED STATES OF AMERICA, *District of Colorado:*

Know all men by these presents that G. G. Symes and Robert E. Foot are held and firmly bound unto James Grant and James B. Grant in the full and just sum of five hundred (500) dollars, to be paid to the said James Grant & James B. Grant; to which payment, well and truly to be made, we bind ourselves, our heirs, executors, and administrators, jointly and severally, firmly by these presents. Sealed with our seals and dated this 8th day of February, in the year of our Lord one thousand eight hundred and eighty-three.

Whereas lately, at the October term, A. D. 1882, of the circuit court of the United States for the district of Colorado, in a suit pending in said court between Winfield Scott Keyes and Albert Arents, and James Grant and James B. Grant, defendants, judgment was rendered against the said Winfield Scott Keyes & Albert Arents, who having * obtained a writ of error to reverse the judgment of the said court, and a citation, directed to the said James Grant & James B. Grant, citing and admonishing them to be and appear at a Supreme Court of the United States to be held at Washington, D. C., on the eighth day of October next:

Now, the condition of the above obligation is such that if the said Winfield Scott Keyes and Albert Arents shall prosecute said writ of error to effect, and answer all damages and costs if they fail to make good their plea, then the above obligation to be void; else to remain in full force and virtue.

(Signed) G. G SYMES. [SEAL.]
" ROB'T E. FOOT. [SEAL.]

Approved Feb. 9, 1883.

(S'g'd) MOSES HALLETT, *Judge.*

302 [Endorsed:] Gen. No. 613. Circuit court of the United States, district of Colorado. Winfield Scott Keyes & Albert Arents *vs.* James Grant & James B. Grant. Bond by Keyes *et al.* on writ of error. $500.00. Filed this 9 day of Feb'y, A. D. 1883. (S'g'd) Edward F. Bishop, clerk.

And the said writ of error is hereto attached, to wit:

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* Obtained a writ of error to reverse the judgment of the said court, or having proved and been allowed an appeal from said decree to the —— court of the United States.

Writ of Error.

303 Writ of Error to Circuit Court U. S., District of Colorado.

UNITED STATES OF AMERICA.

UNITED STATES OF AMERICA, } ss:
District of Colorado, }

The President of the United States to the judge of the circuit court of the United States for the district of Colorado, Greeting:

Because in the record and proceedings, as also in the rendition of the judgment, of a plea which is in the said circuit court, between Winfield Scott Keyes and Albert Arents and James Grant and James B. Grant, a manifest error hath happened, to the great damage of the said Winfield Scott Keyes and Albert Arents, as by their complaint appears, we, being willing that error, if any hath been, should be duly corrected, and full and speedy justice done to the parties aforesaid in this behalf, do command you, if judgment be therein given, that then, under your seal, distinctly and openly, you send the record and proceedings aforesaid, with all things concerning the same, to the Supreme Court of the United States, together with this writ, so that you have the same at Washington, D. C., on the eighth day of October next, in the said Supreme Court to be then and there held, that the record and proceedings aforesaid being inspected, the said Supreme Court may cause further to be done therein to correct that error what of right and according to the law and custom of the United States should be done.

Witness the Hon. Morrison R. Waite, Chief Justice of the Supreme Court of the United States, this 9th day of February, in the year of our Lord one thousand eight hundred and eighty-three, and of the Independence of the United States the 106 year.

[Seal United States Circuit Court, District of Colorado.]

EDWARD F. BISHOP, *Clerk.*

Allowed by—
MOSES HALLETT, *Judge.*

304 *Return.*

THE UNITED STATES OF AMERICA, } ss:
District of Colorado, }

In obedience to the command of the within writ, I herewith transmit to the honorable Supreme Court of the United States a duly certified transcript of the record and proceedings in the within-entitled case, together with all things concerning the same.

Witness my hand and the seal of said circuit court, at Denver, in said district, this 14th day of March, A. D. 1883.

[Seal United States Circuit Court, District of Colorado.]

EDWARD F. BISHOP, *Clerk.*

[Endorsed:] Gen. No. 613. Circuit court of the United States. Winfield Scott Keyes, Albert Arents, plaintiffs in error, *vs.* James

Grant, James B. Grant. Writ of error to circuit court U. S., district of Colorado. Filed in circuit court of the U. S. this 9th day of Feb'y, A. D. 1883. Edward F. Bishop, clerk. Symes & Foot, attorneys for appellants.

The appellant- in the within-entitled cause having served the within writ of error, by lodging a copy thereof in the clerk's office for the adverse property within 60 days (Sundays exclusive) after the rendering of the judgment complained of, and having given the security required by law, this writ is therefore hereby made a supersedeas.

Dated February 9th, A. D. 1883.

EDWARD F. BISHOP, *Clerk*,
By WM. E. ROGERS, *Deputy Clerk*.

305 *Citation, U. S. —— Court.*

THE UNITED STATES OF AMERICA, *District of Colorado.*

The United States of America to James Grant and James B. Grant, Greeting:

You are hereby cited and admonished to be and appear at a Supreme Court of the United States, to be holden at Washington, D. C., on the eighth day of October next, pursuant to a writ of error filed in the clerk's office of the circuit court of the United States for the district of Colorado, wherein Winfield Scott Keyes and Albert Arents are plaintiffs in error and you are defendants in error, to show cause, if any there be, why the judgment rendered against the said plaintiff-in error, as in the said writ of error mentioned, should not be corrected, and why speedy justice should not be done to the parties in that behalf.

Witness the honorable Moses Hallett, judge of the circuit court of the United States for the district of Colorado, this 9th day of February, in the year of our Lord one thousand eight hundred and eighty-three.

MOSES HALLETT, *Judge*.

306 *Proof of Service.*

THE UNITED STATES OF AMERICA, }
District of Colorado, } *ss:*

On this 9th day of February, A. D. 1883, personally appeared Rob't E. Foot before me, the subscriber, a clerk of the district court of the United States for the district of Colorado, and makes oath that he delivered a true copy of the within citation to Wells, Smith & Macon, attorneys of record of James Grant and James B. Grant, defendants in error herein.

ROB'T E. FOOT.

Sworn to and subscribed before me, this 9 day of Feb., A. D. 1883.

[Seal United States District Court, District of Colorado.]

EDWARD F. BISHOP,
Clerk District Court U. S.

[Endorsed:] Gen. No. 613. Circuit court of the United States, district of Colorado. Winfield Scott Keyes, Albert Arents, plaintiffs in error, *vs.* James Grant and James B. Grant, defendants in error. Citation. Filed in circuit court of the U. S. this 9 day of Feb'y, A. D. 1883. Edward F. Bishop, clerk. Symes & Foot, attorney- for appellents.

Rec'd a copy hereof this Feb'y 9, A. D. 1883.

WELLS, SMITH & MACON,
Def'ts' Att'ys.

307 UNITED STATES OF AMERICA, }
District of Colorado, } *ss:*

I, Edward F. Bishop, clerk of the circuit court of the United States for the district of Colorado, sitting at Denver, do hereby certify the above and foregoing to be a true, perfect, and complete transcript and copy of the record and proceedings heretofore filed or had and entered of record in said court and in a certain cause lately in said court pending, wherein Winfield Scott Keyes *et al.* were plaintiffs and James B. Grant *et al.* were defendants, as fully and completely as the same still remain on file or of record in my office.

In testimony to the above I do hereunto sign my name and affix the seal of said court, at Denver, in said district, this 14th day of March, A. D. 1883.

[Seal United States Circuit Court, District of Colorado.]

EDWARD F. BISHOP, *Clerk.*

Clerk's costs:

Transcript, 677 folios, at 10c.	$67 70
13 tracings of models	10
Certificate	35
	$78 05

Paid by pl'ffs in error.

Endorsed on cover: Colorado C. C. U. S. No. 208. Winfield Scott Keyes and Albert Arents, plaintiffs in error, *vs.* James B. Grant and James Grant. Filed 20th March, 1883.

118-25

No. 208.

SUPREME COURT
UNITED STATES.

OCTOBER TERM, 1885.

WINFIELD S. KEYES, et al.,
VERSUS
JAMES B. GRANT and
JAMES GRANT.

Error to Circuit Court
for District of Colorado.

SUPPLEMENTAL TRANSCRIPT OF RECORD.

PLEAS

In the Circuit Court of the United States, for the District of Colorado, sitting at Denver.

Be it remembered, That heretofore and on, to-wit: the third day of February, A. D. 1886, the same being one of the regular juridical days of the October term, A. D. 1885, of said Court—present, the Honorable Moses Hallett, District Judge, the following proceeding, *inter-alia*, was had and entered of record in said Court, to wit:

WINFIELD S. KEYES and ALBERT ARENTS,
vs.
JAMES GRANT and JAMES B. GRANT.
No. 613.

At this day come the said plaintiffs, by R. E. Foot, Esq., their attorney, and the said defendants, by Thomas Macon, Esq., their attorney, also come, and on motion of the said defendants, it is ordered that the plaintiffs' bill of exceptions heretofore allowed and filed herein on the 7th day of February, A. D. 1883, be amended by inserting therein next before the allegation, "which was all the evidence offered by said defendants, and thereupon defendants rested their case," in words and figures as follows,

to wit: "Thereupon the said defendants, to further maintain the said issues, gave in evidence without objection certain parts of a printed book entitled, 'System der Metallurgie von Doctor J. B. Karsten,' the same spoken of by the witnesses, and purported to be publishing at Berlin, Prussia, in 1831–32, from volume three thereof, at pages 318, 319, 320, as follows, to wit:

System
der
Metallurgie
von
Dr. C. J. B. Karsten.

Dritter Band.

Berlin, 1831.
Gedruckt und verlegt bei
G. Reimer.

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der geschmolzenen Masse aus dem geöffneten Auge der Vorwand, oder durch den Stich aus dem Tiegel oder aus dem Sumpfe des Ofens, angefüllt werden. — Der Vorheerd ist der vordere, nämlich der vor der Brust des Ofens hervorragende Theil des Sumpfes.

Tiegelöfen nennt man diejenigen Schachtöfen, bei denen sich der Heerd ganz im Ofen befindet. Sie sind entweder Augen-Tiegelöfen, wenn die Vorwand mit einem Auge versehen ist, aus welchem die Schlacke ununterbrochen abläuft; oder Stich-Tiegelöfen, wenn die Vorwand ganz geschlossen ist und wenn die geschmolzene Masse mit der Schlacke von Zeit zu Zeit in einen Stichheerd abgelassen wird.

Sumpföfen sind diejenigen Schachtöfen, bei denen sich der Heerd theils im Ofen, theils vor demselben befindet. Die

Schlacke läuft von selbst über den Vorheerd, das Metall und das Schwefelmetall werden in einen Stichheerd (deren man auch zwei zuweilen anbringt) abgestochen. Selten sind die Sumpföfen ohne Stichheerd, und dann wird das Metall mit Kellen aus dem Vorheerd, d. h. aus dem vor der Brust befindlichen Sumpf geschöpft.

Spuröfen sind Schachtöfen ohne Heerd und bloß mit einer Heerdsohle, von welcher die geschmolzene Masse sogleich durch das Auge und durch die Spur in den Spurtiegel läuft. Sind die Spuröfen mit zwei Spurtiegeln versehen, so nennt man sie Brillenöfen. Es lassen sich aber die Spuröfen auch mit Stichtiegeln versehen, obgleich diese Einrichtung sehr selten vorkommt.

Diese verschiedenen Arten des Zumachens lassen sich besser bildlich, als durch eine Beschreibung verdeutlichen. Die Zeichnungen Fig. 461 bis 496, stellen im Längenprofil der Oefen, in deren Grundriß (in der Formhöhe) und in der Vorderansicht alle Arten des Zumachens vor, welche bei den Schachtöfen nur vorkommen können. Es ist dabei, wie schon

erwähnt, ganz einerlei, ob die Oefen Krummöfen, Halbhohöfen, oder Hohöfen sind; auch läßt sich, ohne alle Veränderung des Ofens, nach Belieben diese oder jene Methode des Zumachens wählen. In einigen Gegenden giebt man den Tiegelöfen den Vorzug vor den Sumpföfen; in anderen macht man die Oefen lieber mit einem Sumpf als mit einem Tiegel zu. Die Spuröfen sind bei Operationen, bei welchen ein reguliniſches Metall dargestellt wird, nicht gut anzuwenden, weil die Oberfläche des Metalles zu wenig vor der Oxydation geschützt ist. Vorzüglich würden sie beim Verschmelzen von Bleierzen nicht zweckmäßig sein. Man bedient sich der Spuröfen gewöhnlich bei dem Verschmelzen der Kupfererze, besonders bei dem so genannten Rohschmelzen.

Die Zeichnung Fig 461 bis 463 ist ein Augen-Tiegelofen. Die Schlacke läuft durch das stets offene Auge in der Vorwand. Der Stich, welcher zu dem Stichtiegel führt, ist durch eine von den Ulmen des Ofens gelegt.

Fig. 464 bis 466, stellt ebenfalls einen Augen-Tiegelofen vor, welcher sich von dem vorigen nur dadurch unterscheidet, daß der Stich aus dem tiefsten Punkt des Tiegels zu dem Stichtiegel, durch die Vorwand des Ofens gelegt ist.

Fig. 467 bis 469, ist ein Stich-Tiegelofen. Metall, Stein (Lech) und Schlacke bleiben im Ofen stehen, und werden von Zeit zu Zeit durch den Stich in den Stichtiegel abgelassen. Es ist einleuchtend, daß man mit diesem Stichtiegel noch einen zweiten verbinden könnte.

Fig. 470 bis 472, ist ein Augen-Tiegelofen, dessen Einrichtung mit derjenigen, welche Fig. 464 bis 466 darstellt, ganz übereinstimmt und nur dadurch abweicht, daß der Ofen mit zwei Stichtiegeln versehen ist. Die Schlacke, welche ununterbrochen aus dem Auge rinnt, sammelt sich zuerst in einer tiegelartigen Vertiefung und läuft dann aus dieser durch die Schlackentrift ab, damit sie die Theilchen von reguliniſchem

Metall oder von Schwefelmetall, welche sie aus dem Ofen mit sich fortnehmen könnte, in jener tiegelartigen Vertiefung absetzt.

Fig. 473 bis 475, ist ein Sumpfofen mit verdecktem Auge, indem das Gestübbe unter der Vorwand, den Sumpf in zwei communicirende Gefäße abtheilt. Die Schlacke läuft durch das stets offene Auge zwischen der Vorwand und dem Gestübbe ab. Man bedient sich dieser Art des Zumachens oft, wenn man das reguliniſche Metall mit Kellen ausschöpfen und nicht in einen Stichtiegel aus dem Sumpf abstechen will.

Fig. 476 bis 478, stellt einen Sumpfofen mit ganz offener Brust dar, indem die Schlacke keine besondere Abflußöffnung erhält, sondern unmittelbar über dem Vorheerd durch die Schlackentrift abfließt.

Fig 479 bis 481, ist ein Sumpfofen mit verdecktem Auge und mit einem Stichtiegel, in welchem das in dem Vorheerde gesammelte Metall, oder der Stein (Lech) abgelassen wird. — Diese Art des Zumachens würde fast als die eines Spurofens angesehen werden können, wenn man den kurzen Kanal, oder das Auge, welches den Sumpf unter dem Ofen-

schacht mit dem Vorheerde verbindet, als eine Spur ansehen wollte. Allein der Sumpf und der Vorheerd stehen durch das Auge noch immer als ein paar communicirende Röhren mit einander in Verbindung, weshalb der Ofen kein Spurofen sein kann, sondern immer noch ein Sumpfofen bleibt. — Die Schlacke tritt entweder durch das verdeckte Auge ebenfalls mit in den Vorheerd; oder man wendet auch ein zweites, offenes Auge über dem Vorheerd an, welches nur die Bestimmung hat, die sich im Sumpf des Ofens in zu großer Menge ansammelnde Schlacke, abfließen zu lassen. Bei Schmelzoperationen, bei welchen wenig Schlacken gebildet werden, fehlt das obere, offene Auge, und die Schlacke muß durch das verdeckte Auge ebenfalls in den Vorheerd treten.

Also a translation thereof into the English, in words and figures as follows, to wit:

"(318). The fore-hearth is that part of the crucible projecting in front of the fire-wall of the furnace.

"Crucible Furnaces are those shaft furnaces in which the crucible is entirely on the inside. They are divided into eye-crucible furnaces, and tap-crucible furnaces. The former have an eye in the front wall from which the slag flows continuously, the metal and matte being tapped off at intervals into basins.

"The tap-crucible furnaces are those in which the metal, matte and slag are all tapped off from time to time.

"Sumph-furnaces are those shaft-furnaces in which the crucible is partly in the furnace and partly in front of the furnace. The slag runs off continuously over the fore-hearth. The metal and matte are tapped off into receiving vessels or tap-basins. Sometimes the sumph-furnaces are not provided with tap-basins, and the metal in them is dipped with ladles direct from the fore-hearth.

"Spur or channel-furnaces are shaft-furnaces without a crucible. The molten contents flow through the eye di-

rectly from the furnace-hearth into receiving vessels. These different furnaces can be more advantageously studied from drawings than from written descriptions.

"(319) In some countries the crucible-furnace is preferred; in others, the sumph-furnace. It is not advisable to use the channel-furnace when clean metal is produced. With this furnace the metal is not protected from oxidation. It is used chiefly in smelting copper ores, with a view to producing copper matte.

"The drawings, figures 461 to 463, represent an eye-crucible furnace. The slag runs continuously through a hole in the front wall. The metal and matte are tapped off at intervals through a hole in the side of the crucible.

"The drawings, figures 464 to 466, represent an eye-crucible furnace, which differs from the former, in that the tap-hole is in the front wall and at the bottom of the crucible.

"The drawings, figures 467 to 469, represent a tap-crucible furnace. The metal, matte and slag are tapped off from time to time into receiving basins.

"The drawings, figures 470 to 472, represent an eye-cruble similar to the one represented by drawings, figures 464 to 466; it is provided with two tap-basins. The slag also passes through a basin, for the purpose of allowing the small particles of metal and matte mixed with it to settle.

"(320) The drawings, figures 473 to 475, represent a sumph-furnace with a covered eye, in which the brasque (a mixture of fire-clay and coke dust) under the front wall divides the sumph into two communicating vessels.

"The slag runs off continuously through the eye between the bottom of the front wall and the top of the brasque partition.

"This arrangement is used when it is desired to dip the

clean metal with ladles from the fore-hearth instead of drawing it off into tap-basins.

"The drawings, figures 476 to 478, represent a sumph-furnace with an entirely open breast, in which the slag passes off immediately over the fore-hearth.

"The drawings, figures 479 and 480, represent a sumph-furnace with a covered eye, and with a tap-basin, into which the metal and matte are tapped from the fore-hearth. This furnace might be regarded as a channel-furnace, by simply considering the short canal, or eye, which connects the sumph under the shaft with the fore-hearth, as a channel. But, by means of this short canal or eye, the sumph and the fore-hearth stand in combination with each other as a pair of communicating tubes or vessels; consequently, it is a sumph, and not a channel-furnace. The slag may pass through the covered eye into the fore-hearth, or through an open eye above the fore-hearth, the latter eye being used exclusively for the slag.

"In smelting operations, where little or no slag is produced, the upper eye is dispensed with entirely."

Whereas, it was brought to the attention of the Court, and claimed by plaintiffs, through their counsel, that the translation herein offered by defendants was incorrect, in that it omitted to translate all of the original text on said pages 318, 319, 320, and that said translation was not literal, plaintiffs were allowed to insert their own translation of said pages, which translation is in the words and figures following, to wit:

Page 318:

"The fore-hearth is the fore part of the sumph, namely, that part which projects from the breast of the furnace.

"Crucible-furnaces are those blast-furnaces in which the

hearth lies wholly within the furnace. They are either eye-crucible furnaces, when the forewall is provided with an eye from which the slag flows off uninterruptedly, or tap-cruicible furnaces, when the forewall is entirely closed and when the molten mass with the slag is let off from time to time into a tap-hearth.

"Sumph-furnaces are those blast-furnaces in which the hearth is partly within and partly before the furnace. The slag flows of itself over the fore-hearth; the metal and the matte are tapped off into a tap-hearth (of which there are sometimes two). Sumph-furnaces are seldom without a tap-hearth, in which case the metal is dipped with ladles out of the fore-hearth, *i. e.*, out of the sumph lying before the breast.

"Channel-furnaces are blast-furnaces without a hearth and only with a hearth-bottom, from which the molten mass flows directly through the eye and through the channel into the channel-cruicible. When channel-furnaces are provided with two channel crucibles, they are called spectacle-furnaces. But channel-furnaces may also be provided with tap-crucibles, although this arrangement occurs very seldom.

"These different manners of closing can be better explained pictorially than by description. The drawings, figures 461 to 496, represent, in longitudinal profile of the furnaces in their ground plan (of the furnace level), and in the front view, all manners of closing which can at all occur in blast-furnaces, and it is, as already remarked, wholly immaterial whether the furnaces are low furnaces, half-high furnaces, or high furnaces; also, without at all altering the furnace, the one or the other method of closing may be selected at pleasure. In some regions crucible-furnaces are given the preference over sumph-furnaces; in others it is preferred to close the furnaces

with a sumph rather than with a crucible. Channel-furnaces are not well adapted to operations in which reguline metal is produced, because the surface of the metal is too little protected from oxidation. They would be especially impracticable in the smelting of lead ores. Channel-furnaces are generally used in smelting copper ores, especially in so called crude-smelting.

"The drawing, figures 461 to 463, is an eye-crucible furnace. The slag flows through the always open eye in the forewall. The tap, which leads to the tap-hearth, is layed through one of the side walls of the furnace.

"Figures 464 to 466 likewise represents an eye-crucible furnace, which differs from the last only in this, that the tap is layed from the lowest point in the crucible to the tap-crucible, through the forewall of the furnace.

"Figures 467 to 469 is a tap-crucible furnace. Metal, stone (matte) and slag remain standing in the furnace, and are let off from time to time through the tap to the tap-crucible. It is obvious that a second tap-crucible might be combined with this tap-crucible.

"Figures 470 to 472 is an eye-crucible furnace whose arrangement wholly corresponds with that which figures 464 to 466 represent, and varies only in this, that the furnace is provided with two tap-crucibles. The slag, which runs uninterruptedly from the eye, first collects in a crucible-like hollow, and then runs off from that through the slag passage, in order that the particles of reguline metal or matte, which it might take with it from the furnace, may be precipitated in this crucible-like hollow.

"Figures 473 to 475 is a sumph-furnace with covered eye, in which the mixture of clay and coal dust under the forewall divides the sumph into two communicating vessels. The slag flows off through the always-open eye between the forewall and the mixture of clay and coal dust.

This kind of closing is used when it is desired to dip the reguline metal with ladles, and not to tap it from the sumph into a tap-crucible.

"Figures 476 to 478 represents a sumph-furnace with wholly open breast, in which the slag receives no special opening for outflow, but flows off directly over the fore-hearth through the slag passage.

"Figures 479 to 481 is a sumph-furnace with covered eye and with a tap-crucible, into which the metal which has collected in the fore-hearth, or the stone (matte) is drawn off. This manner of closing might almost be looked upon as that of a channel-furnace, if one would look upon the short canal, or the eye, which connects the sumph under the furnace-shaft with the fore-hearth. But the sumph and the fore-hearth are still connected with each other, as a pair of communicating pipes, wherefore the furnace cannot be a channel-furnace, but still remains a sumph-furnace. The slag either enters along into the fore-hearth through the covered eye, or a second open eye is provided above the fore-hearth, which has the sole purpose of permitting the slag, which collects in too great masses in the sumph of the furnace, to flow off. In smelting operations in which little slag is formed, the upper open eye is wanting, and the slag must also enter the fore-hearth through the covered eye."

Also defendant offered and gave in evidence certain parts of the same work, in words and figures as follows, to wit:

System
der
Metallurgie
von
Dr. C. J. B. Karsten.

Fünfter Band.

Berlin, 1832.
Gedruckt und verlegt bei
G. Reimer.

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60—70 unreinen Schlacken vom Schlichſchmelzen, 9 Granulireiſen, 6 Schlacken vom Glättefriſchen, ſo wie mit 15 Heerd und 6 Vorſchlägen von der Treibarbeit beſchickt. Dieſe Beſchickung wird in etwa 24 Stunden verſchmolzen, wobei 55 Centner Werke und 36 Centner Stein erhalten werden. — Häufiger findet aber auch ſchon das erſte Durchſtechen des Steins, ſo wie alle die folgenden Steinſchmelzungen, in einem niedrigen Schachtofen, oder in einem ſogenannten Krummofen ſtatt. Die Einrichtung dieſes Krummofens ergiebt ſich aus den Zeichnungen Fig. 858, im Horizondaldurchſchnitt in der Formhöhe, Fig. 860, im ſenkrechten Durchſchnitt von der Form bis zur Vorwand, und Fig. 859, in der vorderen Anſicht. Die Art des Zumachens iſt wie bei den Hohenöfen zum Schlichſchmelzen. Die Form liegt 14 Zoll über der Horizontalfläche des Vorheerdes. Die Höhe des Schachtes von der Form bis zur Gicht beträgt 44 Zoll Calenbergiſch. Die Neigung oder die Doſirung der Formwand, der Vorwand und der beiden Seitenwände iſt aus der Zeichnung erſichtlich. Der Schacht hat an der Form- und an der Vorwand eine gleiche Breite; die Tiefe von der Form bis zur Vorwand, in der Formhöhe, beträgt 42 Zoll Calenb. — Als Brennmaterial bedient man ſich der Koaks, welche mit der Hälfte, dem Volum nach, Fichten-

zapfen gemengt werden. Die Gicht wird dunkel gehalten und es darf die Flamme auf der Gicht nicht durchbrechen. Zu 100 Ct. geröstetem Stein wendet man eine Beschickung an von 55 —60 unreinen Schlichschlacken, 6 Bleifrischschlacken, 3 granulirtem Roheisen, wobei noch 12 Heerd und 6 Vorschläge von der Treibarbeit mit verschmolzen werden. Seit kurzer Zeit hat man angefangen, das Granulireisen durch Braunspath und auch durch Kalkspath zu ersetzen und gar kein Roheisen mehr anzuwenden. Der Erfolg soll sehr günstig sein. Ohne Zweifel würde die Anwendung des Braunspathes in den Hohenöfen nicht minder günstig ausfallen. In 24 Stunden werden 100

Also a translation thereof into the English in words and figures as follows, to wit:

"System of Metallurgy, by Doctor C. J. B. Karsten, V. volume. Published at Berlin, by G. Reimer, in 1832, page 166.

"The arrangement of this furnace is shown by the drawing, figure 858, representing a horizontal section through the tuyere; figure 860, a vertical section from the back to the front wall through the tuyere, and figure 859, a front view. The method of operating this furnace is the same as in the high furnace used in smelting slimes. The tuyere is fourteen inches above the horizontal surface of the fore-hearth. The height of the shaft from the tuyere to the feed door is 44 inches (Calinbergish measure).

"The inclination of the back, front and side walls, is shown in the drawing.

"A shaft has the same width in front and behind.

"The depth from the back to the front wall through the tuyere is 42 inches (Calinbergish measure)."

Also, the said defendants offered together with the said translations certain figures from the Atlas of Plates accompanying said work, marked 473, 475, 858, 859, 860, copies of which are hereto attached."

UNITED STATES OF AMERICA, } ss.
District of Colorado. }

I, Edward F. Bishop, clerk of the Circuit Court of the United States, for the District of Colorado, sitting at Denver, do hereby certify the above and foregoing to be a true, perfect, and complete transcript and copy of a certain order heretofore had and entered of record in said Court, and in a certain cause lately in said Court pending, wherein Winfield Scott Keyes *et al.* were plaintiffs, and James B. Grant *et al.* were defendants, as fully and completely as the same still remains of record in my office.

In testimony to the above, I do hereunto sign
[L. S.] my name and affix the seal of said Court, at Denver, in said District, this 3d day of February, A. D. 1886.

.....

Clerk.

By .....

Deputy Clerk.

FILED
MAR 31 1886
JAMES H. McKENNEY,
CLERK.

118-25

No. 208. *October Term, 1885.*

Supreme Court of the United States.

KEYES & ARENTS

vs.

JAMES D. GRANT AND JAMES GRANT.

Brief for Plaintiffs in Error.

GEORGE HARDING,
G. G. SYMES,
FRANCIS T. CHAMBERS.

Allen, Lane & Scott, Printers, Nos. 229 and 231 South Fifth Street, Philadelphia.

Supreme Court of the United States.

October Term, 1885. No. 208.

Keyes & Arents	Writ of Error.
vs.	Circuit Court United States for the District of Colorado.
James D. Grant and James Grant.	

BRIEF FOR PLAINTIFFS IN ERROR.

Statement of the Case.

This is an action at law to recover damages for the infringement of letters patent No. 121,385, issued November 28th, 1871, to Keyes & Arents, the plaintiffs in error.

The Invention.

The specification and drawing forming a part of the patent are printed, Record, page 27. The objects of the patentees being, as they state, to provide means for automatically withdrawing clean molten lead from a furnace wherein lead is being smelted, and at the same time to prevent the formation of incrustations of hard matter upon the bottom and sides of the furnace; both of these purposes being accomplished by the simple device of constructing a basin on the outside of the furnace and above the bottom thereof, the elevated lead-well or basin and the furnace being connected by a tube passing upwards from the bottom of the furnace to the bottom of the lead-well.

The mode of operation of this patented furnace is appa-

rent at a glance. As the reduction and melting of the ores in the furnace proceeds, the molten metal and slag of course fall to the bottom, and there separate by subsidence, the molten slag, which is only half as heavy as the lead, of course floating on top. The molten lead gradually fills up the bottom of the furnace, rising at the same time in the tube C until it runs into the bottom of the basin or lead-well. A glance at the drawing of the patent will show that by reason of this construction the bottom of the furnace up to, or nearly up to the level of the bottom of the exterior elevated basin, must always be filled with molten lead, and that the lead which issues from the furnace must always come from the bottom of this fluid mass, which can only be withdrawn from the furnace as new metal falls from the ore.

In its gradual passage from the level of the bottom of the basin to the tube opening in the bottom of the furnace, the molten metal has ample time and space to free itself thoroughly from lighter impurities which come down with it from the ore, and the metal which rises through the tube into the basin must therefore evidently be perfectly pure and free from slag.

It is also self-evident that the gradually subsiding stratum of molten lead must effectually protect the bottom of the furnace walls against the formation of slag incrustations, since no considerable mass of slag can penetrate below the level of the bottom of the elevated basin, and the extreme bottom of the furnace and the tube leading from it is effectually protected against contact with anything but pure lead.

The Pleadings and Trial.

The complaint, charging the defendants in error with the infringement of this patent was filed November 3d, 1880, and on the twelfth day of January, 1881, defendant filed a plea charging the invalidity of the patent, for the reason that the invention therein described and claimed as the invention of the plaintiffs in error had been,

First, in public use with the knowledge and permission of the patentees for such time "that their exclusive right, if any they had, was abandoned."

Second, In public use in the United States by a number of specified individuals at a time prior to the invention of the patentees.

Third, Described and shown in a number of patents and publications before the patentees' invention thereof. (Record, page 46.)

The replication was filed January 18th, 1881, and subsequently the defendants' plea was amended and added to by the citation of a number of additional publications and patents, said amendments being filed February 28th, 2881 (page 8); March 16th, 1881 (page 10); April 1st, 1881 (page 11); July 9th, 1881 (page 13); July 16th, 1881, (page 14); and October 12th, 1881 (page 17).

The case was called for trial May 29th, 1882, and resulted in a mistrial, the jury having failed to agree, and a second trial being had beginning November 15th 1882, it was concluded November 20th, by a verdict for the defendants in error, given under *a binding instruction* from the court. On December 7th, 1882, the court entered judgment on this verdict, and on the same day the plaintiffs were given leave to file their bill of exceptions within sixty days. On the 7th of February, 1883, the bill of exceptions was settled and approved by the court and on the ninth day of February, 1883, the plaintiffs in error sued out their writ of error, which was on the same day duly allowed, an approved bond of the usual form filed, and a citation duly served upon the defendants and their solicitor.

The Evidence.

Plaintiffs' Evidence in Chief.

It appears by the record that the plaintiffs opened their case; by putting in evidence their patent (page 27);—proving infringement through Mr. James B. Grant (one of the defendants in

error), who testified that the defendants had used two furnaces embodying the patented invention in 1878 and eight in 1879 (page 33);—the plaintiff Arents gave a brief account of the state of the art of lead smelting at the date of the patentees' invention and of the advantages arising from the invention (testimony of Arents, pages 28-30);—and finally plaintiffs called fifteen gentlemen of high scientific acquirements and long practical experience in the management of lead and other furnaces both in this country and abroad, who united in saying that the specification of the patent is clear and sufficient, that the invention is new, a "great improvement," and highly useful (depositions of Hahn, Eiler, West, Keys, Small, Hardwick, Moss, Biewend, Cooper, Raht, Kustel, Stetefeldt, Moeller, Ruger, and Christy pages 30-33).

Defendants' Evidence.

The defendants in error put in evidence certain drawings and translated passages from a book published in Berlin, in 1831, and known as "Karsten's System of Metallurgy." The drawings referred to being bound in the Record, facing page 39, and the passages from the text being printed in the Supplemental Transcript.

James B. Grant, pages 33 to 62.

Defendants' first and principal witness was Mr. James B. Grant, one of the defendants, who testified that he had built a furnace in construction and scale like the one pictured in Karsten's drawing, No. 860, had smelted lead ores therein and ascertained that he could so operate it as to obtain clean lead from the fore-hearth. *When* operating in this way, he says "the principle involved" (pages 38 and 40), is the same as that involved in the Keys & Arents patent.

Mr. Grant admits (*a*) that he never knew of such a furnace as that of the Karsten drawing being used (page 39); (*b*) that it was necessary to change the position of the slag eye in order to get clean metal in the fore-hearth (page 39); (*c*) that "careful work" was necessary to avoid getting slag in the fore-hearth (page 40); (*d*) that it was never contemplated

by the author to use this furnace as he used it in his experiments (page 50; see also Karsten's description of the mode of use of a somewhat similar furnace; pages 41-42); (*e*) that the drawing is a mere "ideal representation" (page 50); (*f*) that Karsten does not suggest the idea of using his "ideal" fore-hearth for drawing off clean metal (page 52), but on the contrary, had a distinct object in running the slag from the furnace over the fore-hearth (page 57); (*g*) that to his own knowledge and belief all furnaces having fore-hearths have for fifty years past had a canal leading from the fore-hearth to a depressed basin as a means of getting clean metal (page 59); and (*h*) that the Keys & Arents invention has become the prevailing mode of construction and operating lead furnaces and is regarded by the leading smelters as a great improvement (page 60).

The above testimony all relates to the withdrawal of clean lead from the furnace. As to the other feature of the Keys & Arents' device, the protection of the bottom of the furnace from incrustations or accretions, Mr. Grant, in his direct testimony (page 25), seeks to give the impression that the patented structure adds little or nothing to the utility of a furnace in this respect, but on cross-examination (page 60), he admits that the patented device does prevent accretions, but qualifies his admission by asserting that there was ***another*** known device which possessed some of the *same advantages.*

Professor Bieger, pages 62 to 69.

This gentleman thinks the Karsten drawing No. 860, "similar "in principle" to the Keys & Arents invention (page 63). He had seen the furnace built by Grant, but says it was "*not exactly*" like the drawing, but in answer to the further question as to whether it "*resembled it any*" he says "*yes*" (page 63). He is asked to describe certain furnaces which he saw in Spain and which he says were "similar in principle" to "Karsten's" and does so by explaining that they had but the ***one tap*** through which, of course, all the slag and metal ran together into the fore-hearth (page 64). "*All there is*" in the Keys & Arents patent is, he thinks, the *downward inclination* of the

lead-well tap (page 65). On cross-examination he says that the lead and slag fall to the bottom of the furnace *mixed up together* (pages 65-6).

"Q. You consider the Keys & Arents lead-well, as con-
"structed by them, an improvement over the old mode of tap-
"ping?"

"A. *Why it is of course; nobody denies that* (page 67)."

Smith, pages 69 to 74.

Says the Grant experimental smelter worked on the "same "principle" as the Keys & Arents furnace (page 69) when so working a "very small quantity" of slag got into the fore-hearth (page 70). Considers the Keys & Arents lead-well improvement on the tap hearth and basin as shown in the Karsten drawing.

Geist, pages 74 to 79.

Mr. Geist testifies that in his opinion there is no particular advantage in the Keys & Arents attachments. On cross-examination he states, however, that he had paid to the patentees two thousand dollars ($2000), for the privilege of using their invention, and modifies his condemnation of the invention by stating that it is advantageous in the treatment of certain rich ores (page 78).

James, pages 79 to 81.

Mr. James testifies that he had seen the Grant experimental furnace at work, and describes how it operated. On cross-examination he states that this SO-CALLED Karsten fore-hearth was kept constantly as full of lead as it would hold, and that when they did dip lead from the fore-hearth they only took out about a hundred pounds at a time (page 81).

Dr. John Percy, pages 82 to 87.

The evidence of this witness was taken at his home in England by commission. He expresses a very positive opinion to the effect that the invention claimed in the Keys & Arents patent is not novel, and goes on to explain that in his opinion, "the Karsten furnace" shown in plate No. 860 could, by

"suitable management," be made to give the same results, and to operate in the same way (pages 82-3). Professor Percy does not explain what he means by the expression "suitable management," and in his reply to cross-interrogations exhibits considerable skill in avoiding direct replies. He admits in reply to the twelfth cross-interrogatory (page 86), that he has never seen furnaces like either the Keys & Arents or the "Karsten" structures.

H. Buerman, pages 87 to 91.

This witness also resides in England, and was examined on commission. He states that he does not consider the Keys & Arents invention to be novel, because its various features, considered separately, had been, he states, in use in sundry places mostly not within the United States. It is hardly necessary to discuss the question as to whether the pre-existence of the separate features of the patented invention spoken of by the witness would have any bearing on the novelty of the entire structure as patented, because such uses being outside of the United States could have no bearing on the validity of the patent in any event.

In answer to the sixth interrogatory, the witness states that he is of the opinion "that the principle claimed by the "patentees" is to be found in figure 860 of Karsten. He mentions also certain other publications as disclosing some of the features of the patented invention, but such publications were not used upon the trial.

John M. Ordway, pages 91 to 94.

This deposition was also taken by commission, the witness residing in Massachusetts. He states (page 93) that he does not think there is any new principle developed in Keys & Arents patent which is not indicated by Karsten and that the patented structure could be "deduced" from Karsten's.

Robert H. Richards, pages 94 to 96.

This deposition was also taken by commission. He gives as his opinion that the action of the patented furnace and of

the Karsten furnace must be very much the same and that the difference in form would not affect the principle on which they operate.

PLAINTIFFS' TESTIMONY IN REBUTTAL.

Albert Arents, pages 97 to 114.

Mr. Arents points out (pages 97–8) that the assumed fore-hearth or tap-hearth of the Karsten drawing No. 860 is adapted and intended like all fore-hearths to receive *the entire molten contents of the furnace*. He explains how entirely different this fore-hearth is from the lead-well of his patent and gives practical reasons why it would be impossible to use a furnace having this fore tap-hearth in the way in which the lead-well of the patent is used. On page 99, he points out the advantage gained by elevating the lead-well above the bottom of the furnace; and beginning on the bottom of that page he explains with great clearness, first, that material alterations would have to be made in the so-called Karsten structure to enable it to smelt ores at all and that even when such alterations had been made, it was practically impossible to operate it so as to get clean metal out of the fore-hearth. The witness expresses himself with great clearness and brevity that it would be difficult to do justice to his direct examination which extends to page 105, by an abridgement. In his cross-examination he states (pages 112 to 113), that a (any) furnace constructed in exact accordance with the Karsten drawing No. 860 would be inoperative and that in his opinion, structural changes must have been made in the Grant experimental furnace in order to make it work at all.

Frank Faure, pages 115 to 120.

Mr. Faure testifies that it is in his opinion, impossible to operate such a furnace as Karsten illustrates in Fig. 860, without changes in its construction and points out at length that to make such a furnace operative, it is necessary to close the slag eye and withdraw *the whole fluid contents* of the furnace into the fore-hearth through the closed eye at the bottom. To

have operated the experimental furnace, he is sure that material changes either in the structure or mode of operation of the furnace, must have been made by Mr. Grant.

Anton Eilers, pages 120 to 128.

Mr. Eilers gives as his opinion that it would be practically impossible to obtain clean metal in the fore-hearth of the so-called Karsten furnace. He describes (page 121), how, by an elaborate and careful method of operating such a furnace, it might be possible to get some lead into the fore-hearth without much admixture with slag and matte, but as he says, this is to treat the furnace as a plaything and is absolutely out of the question in practical operation. As he briefly sums up the difference in the result of the two furnaces. In the alleged Karsten structure it would be by a mode of use never suggested or thought of by the author perhaps possible to obtain a little clean lead in the fore-hearth, while in the Keys & Arents structure it is impossible to get anything else.

Professor Hahn, pages 128 to 131.

Professor Hahn states and gives full reasons for his opinion, that to operate the so-called Karsten furnace at all, it is necessary to modify and change its structure and that even after it is made operative, it would not, without further and very material changes, be possible to obtain clean lead in the fore-hearth, but that the whole fluid contents of the furnace must necessarily escape into this receptacle.

A. Hartwig, pages 131 to 134.

Mr. Hartwig testifies that it would be practically impossible to use a Karsten furnace in any other way than by allowing the slag, matte and metal to escape together into the fore-hearth.

Milton Moss, pages 134 to 138.

Mr. Moss testifies that it would be absolutely impossible to practically withdraw clean molten lead by means of the Karsten fore-hearth.

Winfield Scott Keys, pages 138 to 146.

Mr. Keys is one of the patentees and plaintiffs in error. Like all the other witnesses examined by plaintiffs in error, he is a man of practical experience in lead smelting and his testimony agrees with theirs as to the impracticability of using the Karsten structure so as to practically produce clean metal in the fore-hearth. In his deposition he also reviews at some length the text of Karsten, pointing out that such a use for this furnace was never contemplated or suggested.

The evidence being all in, counsel for the plaintiff in error requested the court to give certain instructions (fourteen in number) to the jury; the court in each case refusing to give such instructions and counsel for the plaintiff excepting (pages 146 to 150), and finally the court instructed the jury to find a verdict for the defendant without considering the case, the plaintiff excepting to such instructions and to the entry of judgment upon the verdict given under these instructions (pages 150-1).

Assignment of Errors.

I.

The court erred in giving a binding instruction to the jury to find for the defendant:—

(*a.*) Because the only question at issue being the indentity of the thing described in the Karsten publication: the nature, construction, mode of operation, and practicability of the Karsten furnace were proper subject-matter for the evidence of experts and all such evidence should have been submitted to the jury together with general instructions as to the rules by which they should consider the evidence.

Bischoff *vs.* Wethered, 9 Wall., 812;
Tucker *vs.* Spaulding, 13 Wall., 453.

(*b.*) Because the evidence of the witnesses introduced in behalf of the plaintiffs in error was received without objection and was before the jury; this evidence contraverted the sufficiency of the Karsten publication, and the practicability of the Karsten furnace, besides pointing out that the differences between the patented and the Karsten furnace were of such a nature as to necessitate a different mode of operation and prevent the same results being obtained by the two furnaces.

This evidence, if true, proved that the Karsten publication was no anticipation of the patented invention, and to judge of its strength or weakness, truth or falsity was exclusively the provence of the jury.

Hickman *vs.* Jones, 9 Wall., 201;
Chandler *vs.* Van Roeder, 24 How., 226;
U. S. *vs.* Tillotson, 12 Wheat., 181;
Greenlief *vs.* Birth, 9 Pet., 299.

II.

The court erred in refusing to give to the jury when requested by counsel for the plaintiffs, the following instruction:—

"That the particular portion of the so-called Karsten furnace, called the forehearth, which is claimed by defendants to be the same as plaintiffs' automatic tap, in order to defeat the plaintiffs' patent, it must have been described in the said Karsten books to be used for the same purpose and for the same object as the plaintiffs' automatic tap and must have practically accomplished the same result; and unless the jury so believe, the said description of a Karsten furnace in the said books cannot defeat plaintiffs' right to recover."

III.

The court erred in refusing to give to the jury when requested by counsel for the plaintiffs, the following instruction:—

"If the jury believe, from the evidence, that the principle that liquids in communicating vessels seek the same level has not been before applied to the purpose of drawing off clean metal from smelting furnaces, when in operation by the same device or mechanical contrivance described in the plaintiffs' specifications to their patent, and has not been practically, fully, and completely described in the foreign publications or works relied on by defendants, they will find for the plaintiffs."

IV.

The court erred in refusing to give to the jury when requested by counsel for the plaintiffs, the following instruction:—

"That before they can find that the plaintiffs' invention or automatic tap has been fully and completely described in foreign publications, so as to defeat the

"patent, they must find from the evidence that the "process, contrivances described in the said foreign "publications must be for the same purpose of with- "drawing clean molten metal, separated from all "other substances, from smelting furnaces, on the "principle that liquids seek the same level in con- "necting vessels, in substantially the same way that "it is done by the plaintiffs' lead-well."

V.

The court erred in refusing to give to the jury, when requested by counsel for the plaintiffs, the following instruction:—

"If the jury believe, from the evidence, that the so-called "Karsten furnace, or Karsten fore-hearth, constructed "according to the description in Karsten's work or "atlas referred to, without any material change, "does not or will not withdraw clean molten metal "from smelting furnaces while in operation, without "any mixture of slag, matte, or speiss, then such "foreign publications will not defeat plaintiffs' patent "or right to recover."

VI.

The court erred in refusing to give to the jury, when requested by counsel for the plaintiffs, the following instruction:—

"That what is a furnace of ordinary construction in 1871, "the date of plaintiffs' patent, and the mode of tap- "ping metal from such furnaces, and the position "and character of the slag exit, are questions of im- "portance in the construction of such a furnace in "considering the process or improvement of the "plaintiffs' patent, because it is to such a furnace "that the plaintiffs claim to have applied their dis- "covery and improvement."

VII.

The court erred in refusing to give to the jury when requested by counsel for the plaintiffs, the following instruction:—

"That there seems to be a little or no dispute in this case "that the plaintiffs are the owners of the patent "right claimed; that the specifications are sufficient- "ly certain in description to enable the discovery "and invention to be carried out and operated from "them; and that it is useful and beneficial in its re- "sults, and an improvement on the old methods of "accomplishing the same results; and the principal "question for the consideration of the jury in this "case is, whether the description of a furnace con- "tained in Karsten's Metallurgy, relied on by the "defense, is substantially the same in its operation "and results as the plaintiffs' patent."

VIII.

The court erred in refusing to give to the jury when requested by counsel for the plaintiffs, the following instruction:—

"That if the said Karsten furnace, constructed substantially "according to the description read from the books, "will not accomplish or bring about the same use- "ful results in the withdrawal and separation of the "clean molten metal from the bottom of a crucible "of the furnace, as the plaintiffs' lead-well, then such "foreign publications cannot defeat the plaintiffs' "patent."

IX.

The court erred in refusing to give to the jury when requested by counsel for the plaintiffs, the following instruction:—

"That the changes in the mechanical arrangements and pro- "portions of the furnace, however unimportant they

"may appear, if they produce a useful and beneficial "result and a substantial improvement in the art of "smelting, such changes, together with the benefi- "cial results obtained, will support the plaintiffs' "patent."

X.

The court erred in refusing to give to the jury when requested by counsel for the plaintiffs, the following instruction :—

"The model presented by the defendants is claimed by them "to be like a Karsten furnace, represented in figure "860 of the Karsten Atlas, and described on page "166, volume 5, of Karsten's works, and other fig- "ures on the same page of the atlas ; and if the jury "find from the evidence, that this model is not like "the said figure 860 of said atlas and the description "on said page 166 in all the essential and material "details, they should not consider it in this case."

XI.

The court erred in refusing to give to the jury when requested by counsel for the plaintiffs, the following instruction :—

"Defendants rely, as a defense, on figure 860, plate 41, in "the atlas of Karsten's Metallurgy, and the descrip- "tion found in volume 5, page 186, of Karsten's "works; and if the furnace claimed to have been "built and operated by the defendants was not sub- "stantially the same as this description, and did not "without any material changes produce the same re- "sults as the plaintiffs' lead-well, they will find for "the plaintiffs."

XII.

The court erred in refusing to give to the jury when requested by counsel for the plaintiffs, the following instruction :—

"On this question of prior publication, in relation to it, the

"court charges you that a description contemplated
"by the law as sufficient to defeat a patent must be
"sufficiently full, clear and concise, so that a person
"skilled in the art to which the invention appertains
"could from the description construct the invention
"of the plaintiffs; and if you find that Karsten does
"not give such a sufficient description in his work,
"of figure 860, as would enable a person skilled in
"the art to produce that invention, or sufficient to
"entitle a party to a patent which would defeat this
"invention, then you are to consider that that figure
"860 does not constitute a defense in this case."

XIII.

The court erred in refusing to give to the jury when requested by counsel for the plaintiffs, the following instruction:

"That they are the judges of whether or not the automatic
"tap of plaintiffs is like the so-called 'Karsten fore-
"hearth', its objects and uses and beneficial results.
"To determine this, they should consider what
"changes have to be made in the construction of a
"Karsten furnace and its operation to make it like
"the automatic tap; that is, has the open slag-eye,
"so-called, been changed into a slag tap-hole; has
"the position of the open eye and slag exit been
"changed; did the Karsten forehearth receive into
"it all the molten masses, while the automatic basin
"receives only clean metal; and was the location of
"the Karsten forehearth, with reference to the front
"and sides of the furnace, the same as the automatic
"tap? Whether these are material changes and
"whether these changes produce useful and bene-
"ficial results in the method of withdrawing clean
"metal from furnaces, are questions of fact for the
"jury; and if the jury believe, from the evidence
"that these changes are material and beneficial in
"their results, they will find for the plaintiffs."

XIV.

The court erred in refusing to give to the jury when requested by counsel for the plaintiffs, the following instruction :—

"That the amount of damages plaintiffs are entitled to re-
"cover is the annual license fixed by them for the
"use of their invention, or automatic tap, which has
"been testified to be $250.00 a year, in advance, for
"the use of each automatic tap attached to a furnace.
"The number of furnaces used by defendants mul-
"tiplied by two hundred and fifty, and then by the
"number of years defendants have used such auto-
"matic taps, will be the measure of plaintiffs' dam-
"ages; such fee is charged in advance, and the frac-
"tional part of a year must be regarded as a whole
"year."

Argument.

It is not disputed in this case:

(*a.*) That the plaintiffs in error are original inventors of the thing patented.

(*b.*) That the specifications of the patent are clear and sufficient.

(*c.*) That the invention is of great practical utility and value.

(*d.*) The patent of generally recognized validity.

(*e.*) That the defendants in error are using the patented invention.

The defendants in error, having in one of their amended pleas set out the book of Karsten as a publication describing the patented invention prior to the supposed invention thereof by the patentees, rested their case at the trial entirely on this publication and the issue before the court and jury was the very simple one of the identity of the description in Karsten with the patented invention.

From the text of Karsten's work, the defendants offered pages 318, 319, 320 of Vol. 3, published in 1831, and page 166 of Vol. 5, published in 1832. Of the three pages from Vol. 3, translations were made by both the plaintiff and defendant which differs in some respects and both are certified from the court below. (See Supplemental Transcript.) The translation from page 166 of the fifth volume (Supplemental Transcript, page 12), is admittedly correct. Together with these extracts from the text of Karsten, drawings from the accompanying atlas, and numbered 473, 474, 475, and 858, 859, 860, were offered in evidence. The first three being different views of *one furnace*, referred to on page 320, and the last three being different views of *another furnace*, referred to on page 166.

None of the defendants' witnesses referred to the furnace shown in Figures 473 to 475, as embodying the plaintiffs' invention, or asserted that it could be made to serve the same purposes or operated in the same way. Neither was it pretended that the furnace shown in Figures 858 to 860 was intended to be used in the manner and for the purposes described in the patent, or that there was anything in the text of the Karsten book which described or suggested the method of

obtaining pure lead from the furnace, and of protecting the bottom thereof, which is described in the patent.

There is then, confessedly, no descriptive matter in this alleged prior publication, which would inform one skilled in the art that it was possible to construct a furnace which would automatically deliver pure lead into an exterior basin, and at the same time effectively protect itself against the formation of accretions about its bottom, nor instruct such a one as to how a furnace should be constructed or used in order to obtain these desirable features and modes of operation. On the contrary, the text of the Karsten book describes in each case a mode of use in which the slag, matte, and metal is all run out into the same receptacle in which the separation of the metal from the other matters is afterwards effected, and if any smelter should build these furnaces and use them in the way described by Karsten, he would never find out that they possessed the capability of delivering pure metal into their fore-hearth, even if it were true that they were capable of being so used.

But just here is where the curious feature of this case appears. As we have already said none of the defendants' witnesses asserted that the furnace shown in Figures 473 to 475 is capable of being used for the same purposes as the patented furnace, *and neither do they assert that* THE FURNACE *shown in the three Figures 858, 859 and 860 could be so used. What they do assert is, that a furnace* CAN *be built having* THE SAME CENTRAL SIDE ELEVATION *as the Karsten furnace,* (the central side elevation of which is shown in Figure 860,) *which would be* CAPABLE *of being used to effect the delivery of pure metal into the fore-hearth,* PROVIDED *the open slag eye was moved to one side of the fore-hearth instead of opening into it as shown in the Karsten drawing.*

The defendants in error claim that they constructed a furnace LIKE FIG. 860; that is, having the same central side elevation, for that is ALL that is shown in Fig. 860. And they and their experts claim that by moving the slag eye to one side, they were able to operate this furnace in such a way that the metallic lead came into the forehearth through the covered eye with very little admixture with slag. They *could* do this, they said, with "careful management." What this careful

management was, is more fully explained by their own witness James, who states (pages 80–1), that they kept the fore-hearth full of lead, just skimming the metal off from its top in driblets. That this was a practicable method of operating the furnace, is too absurd to be even pretended. That it was even possible to operate the furnace at all in this way without materially altering the dimensions of the covered eye and other features shown in the Karsten drawing in addition to moving the slag eye, is denied by some of the most intelligent and experienced of the plaintiffs' witnesses who fortify their opinions by calculations of mathematical accuracy.

But suppose that the defendants' witnesses were right and the plaintiffs' wrong. Suppose that *a furnace* was built which, in its central side elevation, was like Fig. 860 of Karsten. Many such furnaces could no doubt be constructed, but they would not be *the furnace* which Karsten illustrates in the THREE FIGURES, 858, *which is a plan view, 859 which is a front elevation,* and *860 which is a central side elevation.* And by looking at Fig. 858 we see at once why the defendants' witnesses were so careful in their testimony not to refer to the furnace illustrated in plate 41 of Karsten's atlas and referred to in his text, but to "the furnace"? shown in Fig. 860; for the fore-hearth of THE *Karsten furnace* has a tap hole running from it to a lead basin below, *and this tap hole enters the fore-hearth so near its bottom that it is at once evident that the metallic lead in the fore-hearth would never rise to a height sufficient to insure that the covered eye should be protected by columns of metal within and without the furnace from the entrance of the slag.*

The defendants in error then are in the position of claiming that our patent is invalid;—not because Karsten *described* how to construct and operate a furnace in the same way;—not because any man alive *knew* that a furnace could be operated in this way;—not because Karsten *showed* in his plates the construction of *a furnace*, which, in the light of the patentee's specification, a man skilled in the art can now see is capable of being operated to produce some of the useful effects obtained by following the patent;—but because there is in Karsten's atlas the central side elevation of a furnace, which,

if you disregard the other views of the same furnace, you may embody in *a furnace structure* which shall be capable of operating with "careful management" in the same way as the patented furnace.

Such a position is indeed absurd to the last degree, and yet it is absolutely and literally the position of the defendants in error in this case.

The Court might well have taken the case from the jury, but it should have been for the reason that the evidence for the defendants did not in the slightest degree tend to prove that *the furnaces* described or shown by Karsten were like, or substantially like, the patented furnace, and there was therefore no evidence on which the jury could find that the plaintiffs' patent was invalid.

But even if it be conceded that a furnace having the same central side elevation as that shown in Fig. 860 of the Karsten furnace, but not having the perforated forehearth shown by Karsten to exist in his furnace, and having its slag eye placed in an entirely different position, *could be considered as the furnace shown and described by Karsten*, there still remains the hotly contested question as to whether even such a furnace, in view of all that is now known from the publication of the plaintiffs' patent and its wide introduction into use, could be made to so operate as to deliver clean metal into its forehearth. This question of fact should, beyond a doubt, have been left to the jury, and even if it were decided that it could be so used, it would still be unlike the patented furnace in many important particulars, to wit:--

(*a.*) It would obviously lack the automatic action of the plaintiffs' device, which can only deliver lead into its elevated basin when the bottom of the furnace is filled, to a considerable height above the lead exit passage, with metallic lead; while the most that can be claimed for the Grant experimental furnace is that by "careful management" on the part of the operator, he can prevent much slag from getting into the forehearth.

(*b.*) The deep stratum of metallic lead which must exist above the top of the lead exit opening in a furnace constructed like the patented one, and which enables the lead to

thoroughly free itself from lighter impurities before it reaches the exit, can evidently have no practical existence in such a furnace as the Grant experimental furnace.

(*c.*) The protection to the bottom of the furnace and the exit passage against contact with slag or matte and consequent danger of the formation of accretions or incrustations which the patented furnace affords, would not be obtainable by the construction of the Grant experimental furnace.

Whether a furnace, differing from the one patented in all these features, and having its only point of resemblance in its capacity through "careful management" to deliver clean lead into its forehearth, could be considered as anticipating the invention of the patentees, is, to say the least, a question of fact which should have been left to the jury.

It is to be regretted that the court below did not see fit to make the reasons which influenced it in taking this case from the jury a part of the record, and we are thus left to infer the line of reasoning by which the court was misled. It is to minds unfamiliar with technical subjects and their development through invention difficult to understand that the most beautiful and useful inventions are usually characterized by exceeding simplicity, and that great changes and complications of structure and detail, as a rule, involve little or no inventive action in the mind, but are the result of familiarity with mechanical expedients.

One of the natural principles brought into useful operation in the plaintiffs' invention is the equilibrium of fluids in communicating vessels. Communicating vessels undoubtedly exist also in the Karsten furnace, and therefore, say the witnesses for the defendant, the principles involved in the two structures are the same, and on this supposition, and the pure question of fact as to whether or not the Grant experimental furnace was an operative device, the defendants rest their whole case. It must have been then upon this idea,—"that because the *same principle* existed in both the Karsten and the patented furnaces, therefore the two were identical,"—that the court took the case from the jury, overlooking the fact that principles can neither be invented nor patented, and that all invention is but

the adaptation of everlasting and unchanging natural principles to useful work.

If the patentees had undertaken to cover this, or any other natural principle in their claim, it would not be necessary to show that some one else had prior knowledge of the same law of nature, to defeat their patent. But these patentees are *the unquestioned* inventors or discoverers of the means by which this natural principle may be made to co-act with others to automatically deliver clean pure lead from the smelter, and to defeat their patent for this invention, it is not sufficient to say that the capacity for such use was an inherent attribute of a principle or natural law, but it is incumbent on the infringer to show that some one else had recognized this capacity and had notified the public of the means by which it could be practicably utilized. If inventions are to be theorized away on the ground that they consist of merely easily understood and appreciated utilizations of natural laws, which is the line of defense taken to this invention by the experts of the defendant, then the court will be forced to establish as a rule of patentability that inventions must consist either in devices in the nature of perpetual motion machines which must act in defiance to all known principles, or uninvolved complications of mechanism, the principles of which it is difficult or impossible to understand.

To return to the Karsten book which the court had before it, and which even the defendants in error admit contains no descriptive matter which indicates that the author knew of the possibility of operating a smelter in the way specified by the patentees, we find that Karsten depended on a totally different principle to effect the purification of his lead, viz.: that of the natural law by which lead remains fluid at temperatures at which slag solidifies. Karsten brings all his lead and slag out into his forehearth and *there* they separate according to their specific gravities; the lead at the bottom and the slag on top, where it is not only withdrawn from the heat of the furnace, but directly in contact with the air; of course under these conditions the slag chills and solidifies and may be thrown off from the lead or the lead withdrawn from beneath it, as is indicated by Karsten in plate 41. This last method of tapping

the lead from the forehearth was, the defendants' experts testified, the one universally in use with furnaces having forehearths.

Grant, page 59.

The principle then on which Karsten relied to free his lead from slag was different from the principle utilized by the patentees, and necessitated the addition to the forehearth of an independent lead-well below the hearth, and the principle of the equilibrium of fluids in communicating vessels was not utilized and could not be utilized to aid in the purification of the metal without a complete abandonment of the principle on which Karsten relied to do this work, and a complete change in the conditions and appliances by which it was brought into action.

Except then in the sense that all structures, processes, and methods are at all times subject to all natural laws, there is no similarity in the operative principle of the Karsten and the patented furnace.

The instructions for the jury which plaintiffs' counsel requested at the close of the trial and which were refused by the court are imbodied in the assignments of error numbered 2 to 14; in part they relate to the disputed matters of fact as to the operation of the Grant experimental or so-called Karsten furnace, and if the evidence on this matter were allowed to go to the jury, there can be no question but that such instructions should have been given them.

The instructions requested in behalf of the plaintiff as to what an alleged prior publication must contain to constitute it an anticipation of a patent, are in accord with the law as declared by this court in Seymour *vs.* Osborne, 11 Wall., 555.

But it is not necessary to discuss the exceptions in detail since it will probably not be disputed that if this case should have gone to the jury, it should have been with instructions substantially as requested.

Respectfully submitted,

GEORGE HARDING,
G. G. SYMES,
FRANCIS T. CHAMBERS,
Of Counsel for Plaintiffs in Error.

Winfield Scott Hancock and Albert Arnold, Plaintiffs in Error,

vs.

James B. Grant and Jacob Grant, Defendants in Error.

Brief on Behalf of the Defendants

By

BENJAMIN F. THURSTON,

Supreme Court of the United States.

OCTOBER TERM, 1885.

WINFIELD SCOTT KEYES AND ALBERT ARENTS,
Plaintiffs in Error,
vs.
JAMES B. GRANT AND JAMES GRANT,
Defendants in Error.

No. 208.

BRIEF ON BEHALF OF THE DEFENDANTS IN ERROR BY

BENJ. F. THURSTON.

This is an action at law for damages for the infringement of Letters Patent, No. 121,385, dated November 28, 1871, granted to Winfield Scott Keyes and Albert Arents (plaintiffs below and plaintiffs in error in this court) for improvement in Furnaces for Smelting Lead and other Ores. A copy of the patent will be found on pp. 27 and 28 of the record.

After all the testimony had been submitted before the jury, the Circuit Court was of opinion that the plaintiffs

were not entitled to recover, and thereupon instructed the jury to find a verdict for the defendants. To this instruction the plaintiffs excepted, and presented numerous requests for matters to be given in charge to the jury, all of which were refused, and for such refusals exceptions were taken.

It is open to grave question whether any one of the specific exceptions is tenable, from defects in form, failure to set out the testimony which would authorize the proposition that the truth of the matter therein contained should be weighed by the jury, or because asking instructions upon abstract propositions of law not shown by the exceptions to be relevant to the issues; but inasmuch as the error on the part of the court below (if any there be) rests upon the action of the court in instructing the jury to find a verdict for the defendants upon the whole case as presented at the trial, the correctness of this action will be considered upon the assumption that such direction is in proper form in the exceptions as stated, brought up for review by this court.

It is now the settled law of this court, since the case of *Improvemeat Co.* vs. *Munson*, 14 Wall. 442, that in every case, before the matter in issue is submitted to the jury, there is a preliminary question for the judge,—not whether there is literally no evidence, but whether there is any upon which a jury can properly proceed to find a verdict for the party producing it, upon whom the *onus* of proof is imposed.

Again, it has been repeatedly declared that—

> "It is the settled law of this court that when the evidence given at the trial, with all inferences that the jury could jus-

tifiably draw from it, is insufficient to support a verdict for the plaintiff, so that such verdict, if returned, must be set aside, the court is not bound to submit the case to the jury, but may direct a verdict for the defendant.*

A consideration of the record of the case will show not only that the court was justified in directing a verdict for the defendant, but that if the case had been submitted to the jury and a verdict for the plaintiffs rendered, it would have been the duty of the court to have set the same aside, and have ordered a new trial before acquiescing in such finding. Essentially the preliminary question which the judge was bound to consider was, whether a smelting furnace already known to the art, and described and illustrated in a printed publication long prior in date to the plaintiffs' patent, exhibited the same organization in principle, and involved, or was capable of involving the same method for withdrawing the molten metal. It was also entirely competent for the judge presiding at the trial in case the prior publication described a furnace, which when constructed and put to use would be practically inferior to the furnace described in the plaintiffs' patent, to exercise his judgment whether such differences were due only to improvements in mechanical construction involving no difference in principle. Furthermore, in case the prior publication was not an exact anticipation of the patent, it might nevertheless be clear that the inventive faculty was not required to be exercised to produce the specific organization of form shown in the plaintiffs' patent. In such cases it would not only be proper, but it would be the

* *Improvement Co.* vs. *Munson*, 14 Wall. 442; *Pleasants* vs. *Fant*, 22 Id. 116; *Herbert* vs. *Butler*, 97 U. S. 319; *Bowditch* vs. *Boston*, 101 Id. 16; *Griggs* vs. *Houston*, 104 Id. 553; *Randall* vs *B. & O. R. R. Co.*, 109 Id. 178; *Anderson County Commissioners* vs. *Beal*, 113 Id, 227; *Baylis* vs. *Insurance Co.*, Id. 316; *Schofield* vs. *Railway Co.* 114 Id. 618.

duty of the court to incur no risk as to the miscarriage of justice, by submitting questions to be determined by the jury which, by the decisions of this court, fall more appropriately within the province of the judge.*

The Keyes and Arents Patent.

The improvement set forth in the patent as the subject of invention is one capable of being readily understood from a reading of the text and an inspection of the drawing. It relates simply to a method of tapping a lead furnace which consists in the employment of a basin to receive the molten metal, located at a suitable elevation above the bottom of the furnace, such basin being connected with the interior of the furnace by means of a connecting tube. Shortly stated, the patentees propose, in place of tapping a lead smelting furnace by withdrawing the molten metal through a tap-hole near the bottom, to allow such metal to flow upward into a receiving basin under the operation of the familiar natural law, that liquids will seek the same level in communicating vessels. The theory upon which the patent is based, is that clean metal, unaccompanied with slag or other impure products resulting from the operation of smelting lead ores, will, by reason of its greater specific gravity, settle to the bottom of the furnace, and will ascend through the connecting tube—as the mass of

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* *Bischoff* vs. *Wethered*, 9 Wall. 812; *Seymour* vs. *Osborne*, 11 Wall. 516; *Powder Co.* vs. *Powder Works*, 98 U. S. 126; *Heald* vs. *Rice*, 104 U. S. 749.

molten metal rises within the furnace—into the receiving basin, from which it can be dipped with a ladle.

The claim of the patent is to

> "The method of tapping or withdrawing molten lead or other metals from a smelting furnace, by means of a basin B, and tube or connection C, in combination with the furnace, substantially as shown and described."

The art of smelting metals is one of the oldest of human industries. A well-known form of smelting furnace would consist of a cylindrieal shaft lined with fire-resistant material, and located above a crucible or receptacle for the metal when melted. This shaft is charged with fuel and with the proper proportions of ore and flux. Holes extend through the wall of the furnace underneath the charge, through which blasts of air are forced under pressure, to stimulate the burning of the fuel and to melt the ore. The metal which the ore contains, when reduced to fluidity by the action of the fire, settles downward to the bottom or hearth of the furnace, from which it can be withdrawn by opening a hole through the wall of the furnace near the bottom, which hole, while the ore is being smelted, is closed with a plug of clay. The stream of metal issuing from the exit-hole is caught at the tap by ladles, for pouring into moulds, or is received into a basin or receptacle from which the metal can be dipped.

In the reduction of ores by smelting, a large quantity of slag or refuse matter is formed, and which is also in a molten state. To remove this slag, so that it shall not become commingled to an injurious degree witn the clean metal, a hole is made through the wall of the furnace at a suitable elevation, and through which hole the slag, at

stated periods, or as it is formed, is drawn off. This slag exit-hole can be closed at pleasure with a plug of clay.

The plaintiffs' improvement contemplates no change in the construction of the essential parts of a smelting furnace beyond what would be comprehended in the statement that the exit-hole for the metal at the hearth is connected by means of a conducting pipe with an exterior elevated basin for receiving the molten metal, whenever the metal inside the crucible or lower part of the furnace stands at a height above the plane of the bottom of the receiving basin.

The Karsten Publication of A. D. 1831.

The defendants put in evidence certain extracts from the text and illustrative drawings of smelting furnaces of the authoritative treatise upon Metallurgy by Dr. J. B. Karsten, of Germany, published at Berlin in 1831-32.

At Vol. III, p. 318, definitions are given of the terms of description employed in the classification of smelting furnaces, as follows :

"(318) The *fore-hearth* is that part of the crucible projecting in front of the fire-wall of the furnace.

"*Crucible Furnaces* are those shaft-furnaces in which the crucible is entirely on the inside. They are divided into eye-crucible furnaces, and tap-crucible furnaces. The former have an eye in the front wall from which the slag flows continuously, the metal and matte being tapped off at intervals into basins.

"The *tap-crucible* furnaces are those in which the metal, matte and slag are all tapped off from time to time.

"*Sumph-furnaces* are those shaft-furnaces in which the crucible is partly in the furnace and partly in front of the furnace. The slag runs off continuously over the fore-hearth.

The metal and matte are tapped off into receiving vessels or tap-basins. Sometimes the sumph-furnaces are not provided with tap-basins, and the metal in them is dipped with ladles direct from the fore-hearth.

"*Spur* or *channel-furnaces* are shaft-furnaces without a crucible. The molten contents flow through the eye directly from the furnace-hearth into receiving vessels. These different furnaces can be more advantageously studied from drawings than from written descriptions.

"(319) In some countries the crucible-furnace is preferred; in others, the sumph-furnace. It is not advisable to use the channel-furnace when clean metal is produced. With this furnace the metal is not protected from oxidation. It is used chiefly in smelting copper ores, with a view to producing copper matte.

"The drawings, figures 461 to 463, represent an eye-crucible furnace. The slag runs continuously through a hole in the front wall. The metal and matte are tapped off at intervals through a hole in the side of the crucible.

"The drawings, figures 464 to 466, represent an eye-crucible furnace, which differs from the former, in that the tap-hole is in the front wall and at the bottom of the crucible.

"The drawings, figures 467 to 469, represent a tap-crucible furnace. The metal, matte and slag are tapped off from time to time into receiving basins.

"The drawings, figures 470 to 472, represent an eye-crucible similar to the one represented by drawings, figures 464 to 466; it is provided with two tap-basins. The slag also passes through a basin, for the purpose of allowing the small particles of metal and matte mixed with it to settle.

"(320) The drawings, figures 473 to 475, represent a sumph-furnace with a covered eye, in which the brasque (a mixture of fire-clay and coke-dust) under the front wall divides the sumph into *two communicating vessels*.

"The slag runs off continuously through the eye between the bottom of the front wall and the top of the brasque partition.

"This arrangement is used when it is desired *to dip the clean metal with ladles from the fore-hearth instead of drawing it off into tap-basins*.

"The drawings, figures 476 to 478, represent a sumph-furnace with an entirely open breast, in which the slag passes off immediately over the fore-hearth.

"The drawings, figures 479 and 480, represent a sumph-

furnace with a covered eye, and with a tap-basin, into which the metal and matte are tapped from the fore-hearth. This furnace might be regarded as a channel-furnace, by simply considering the short canal, or eye, which connects the sumph under the shaft with the fore-hearth, as a channel. But, by means of this short canal or eye, the sumph and the fore-hearth stand in combination with each other *as a pair of communicating tubes* or vessels; consequently, *it is a sumph*, and not a channel-furnace. The slag may pass through the covered eye into the fore-hearth, or through an open eye above the fore-hearth, the *latter eye being used exclusively for* the slag.

"In smelting operations, where little or no slag is produced, the upper eye is dispensed with entirely."

(Vol. V, p. 166) "The arrangement of this furnace is shown by the drawing, figure 858, representing a horizontal section through the tuyere; figure 860, a vertical section from the back to the front wall through the tuyere, and figure 859, a front view. The method of operating this furnace is the same as in the high furnace used in smelting slimes. The tuyere is fourteen inches above the horizontal surface of the fore-hearth. The height of the shaft from the tuyere to the feed door is 44 inches (Calinbergish measure).

"The inclination of the back, front and side walls, is shown in the drawing.

"A shaft has the same width in front and behind.

"The depth from the back to the front wall through the tuyere is 42 inches (Calinbergish measure)."

I would respectfully submit that from the foregoing description, when read in the light of the drawings (Rec. between pp. 38 and 39,) it is clear that a smelting furnace which is constructed with a "sumph," or a crucible or hearth which is partly within the walls of the furnace and partly without such walls, such sumph being divided by a partition with an opening at the bottom of the same, so that all of the crucible that is upon one side of the partition is within the furnace, and all of the crucible that is upon the other side of the partition is exterior to the furnace, but the two chamber receptacles or basins so formed

by the partition being in communication, must operate upon the principle described in the plaintiff's patent.

The "eye," which is the passage-way between the "two communicating vessels," is described as a "covered eye;" that is, covered by the molten clean metal, which, being the heaviest of the products from the ore, has first entered the interior of the vessel and passed through the communicating eye into the exterior basin, in which it will rise as the height of the body of molten metal rises in the interior of the vessel. The slag aud other products of less specific gravity than the clean or reguline metal, will naturally rise to the top of the clean metal upon the interior vessel or hearth, and will be prevented by the dividing partition from passing through the communicating eye in any considerable degree into the exterior vessel or forehearth.

Provision is made for running off the slag floating on the surface of the metal within the furnace, through a slag eye located near the top of the partition, and it is expressly stated that "this arrangement is used when it is desired to dip the clean metal with ladles from the forehearth instead of drawing it off into tap-basins.

The plaintiffs' patent does not describe in the text, or show in the drawings, any "slag eye," but it is manifest that the slag and other products than clean metal, resulting from the process of smelting lead ore, must be gotten rid of in some way, and as the patent relates to an improvement upon the ordinary furnace, it is to be presumed that the plaintiffs intend to discharge the accumulating

slag by providing their furnaces with a proper exit channel for the slag.

The drawings, Nos. 858, 859 and 860 of Karsten's treatise are perfectly intelligible without any descriptive text, but they may be read in connection with the description of the furnaces embodying the same principle, described on pp. 318-320 of Vol. III The dimensions of the furnace are given, and its construction made clear to any person at all familiar with the subject by drawings in front view and in horizontal and in vertical section.

It does not require any explanation from experts to advise the court that these drawings show a "sumph" furnace having two communicating lead receptacles, one of which is located within the furnace and primarily receives the molten metal, and the other receptacle is exterior to the furnace and receives its clean metal from the eye communicating with the interior receptacle. It is apparent that the eye communication between the two vessels is closed, in the sense that it is submerged by the metal in the vessels. If clean reguline metal will, from its greater gravity settle upon the bottom of the hearth or crucible in the plaintiffs' furnace, the same natural law will be in operation when the Karsten furnace is working. If clean metal which has settled to the bottom of the interior chamber of the plaintiffs' furnace will flow up the connecting-tube into the receiving basin as the result of a natural law, modified by the effect of the pressure incident to the blast introduced through the tuyeres and by the superincumbent weight of the slag and other products, so also, by the same laws will clean metal pass through the covered eye in the Karsten furnace into the bottom of the exterior receiving basin, and rise under the same law in such vessel

as the molten mass rises in height upon the bottom of the interior hearth.

This proposition of fact and of the operation of natural laws is too plain for discussion. The truth of the statement is not denied by the plaintiffs themselves, who testified as witnesses, or by any person called in their behalf; but they say only, in effect, that the Karsten furnace, when constructed according to the description in Karsten's treatise, as illustrated by the drawings, would not operate practically as usefully as a furnace constructed according to the form, and of the materials, and in the manner shown in the plaintiffs' patent. One objection is, that the partition in the Karsten furnace which separates the hearths into communicating vessels, is made of brasque, a mixture of fire-clay and coke-dust, and that it is less enduring than a partition of fire-brick would be. This material, however, is suitable for a furnace of small capacity, such as was commonly employed for reducing particular kinds of ore obtained in comparatively small quantities from the district in the neighborhood of Freiberg. It is enough for the purposes of the application of the rule of law to the case, that brasque is a fire-resistant material, although it may be inferior to other natural or artificial substances.

Another objection is that the height of the receiving chamber within the furnace below the tuyeres, or blast passages, is not as great as it should be for the best effects, and that under the influence of the interior pressure induced by the blast and other causes more or less slag, which is of less specific gravity than the pure reguline metal, would be forced through the covered eye into the exterior chamber. This, if true, would exhibit no fault in principle, but only a fault in construction. On the other

hand, the testimony is, that in the plaintiffs' furnace other products than clean metal can be made to pass into the receiving basin in the event that the furnace is improperly managed, and it is quite apparent that if the interior pressure be made too great, or if the proper conditions for the working of the furnace are not strictly observed, impure substances could be forced mechanically through the ascending spout in the plaintiffs' furnace, less readily, perhaps, than they would be in a furnace constructed according to Karsten's drawings, but by the effect of the operation of the same set of laws and forces.

Another objection is, that the Karsten furnace has a slag eye directly over the receiving basin, and that the diameter of this eye is too large for the successful practical operation of the furnace. This again, if true, is only a matter to be remedied by construction. It certainly does not constitute invention to change the location of the slag-discharging eye from a position over the fire-hearth to a position more to the right or to the left. It is expressly stated in the description of Figs. 473 and 475, that "the slag runs off continuously through the eye between the bottom of the front wall and the top of the brasque partition," and that "this arrangement is used when it is desired to dip the clean metal with ladles from the fire-hearth instead of drawing it off into tap-basins."

Again, in the description of Figs. 479 and 480, it is stated that "the slag may pass through the covered eye into the fire-hearth, or through an open eye above the fire-hearth, the latter eye being used exclusively for the slag," and that "in smelting operations, where little or no slag is produced, the upper eye is dispensed with entirely."

It seems plain that where ores are being reduced which

yield a large amount of slag, the same would be drawn off through an upper eye, but in smelting operations, where no slag is produced, there will be no occasion for the use of a slag eye.

The essential thing which the court below was entitled to ascertain before the case was submitted to the jury, was whether the Karsten furnaces exhibited a system or method of tapping or withdrawing lead or other metals from a smelting furnace by such construction of furnace as would involve an inner receptacle for molten metal and an outer receptacle connected with the first by a communicating channel or eye, so that the lower strata of reguline metal deposited upon the bottom of the interior crucible or hearth should flow through into the outer basin, from which it can be dipped with ladles. Otherwise stated, do the Karsten furnaces, described and illustrated by drawings, exhibit what may be called a separator, as distinguished from a tap which, when opened, allows the whole molten contents of the furnace, with out any separation, to flow out. Undoubtedly, the mineral resources of Utah, Colorado, and the other mining districts of the United States, are vastly greater in extent than the mining districts in the Hartz mountains, and the operations of smelting, during the last fifteen years, in this country, are on a scale entirely beyond anything that was known in the same industry in Germany in 1831. Furnaces of greatly increased size are required for the necessities of the business and for the reduction of enormous supplies of ores at hand. It is proper to expect that there should be improvements in the mechanical construction of such furnaces. The question, however, is not whether the Keyes & Arents smelting furnace is a better apparatus for money-making purposes than a furnace constructed accord-

ing to the Karsten drawings, but the inquiry is, whether any new principle has been introduced by the plaintiff for withdrawing clean lead from an exterior basin communicating with the interior hearth of the furnace.

I insist that it is impossible to distinguish the principle upon which the Karsten furnace must act from the principle upon which the patent of the plaintiffs describes their furnace to act. The differences are differences only in degree, and not in kind. I submit, therefore, that upon the proof of the Karsten publication disclosed in the record, and assuming that the Keyes & Arents furnace is a more practical apparatus for the present necessities of the times, both as to the material of which it is constructed and as to the arrangement of the receiving-basin relatively to the interior hearth, that the case falls directly within the settled rule of this court as expressed in the case of *Roberts* vs. *Ryer*, 91 U. S. 150, and also within the principle of *Pennsylvania Railway Co.* vs. *Locomotive Truck Co.*, 110 U. S. 490, and *Miller* vs. *Foree*, VI. Sup. Ct. Rep. 204.

The court below, having the Karsten description and drawings before it, was called upon to determine whether any new principle or law of action characterized the plaintiffs' patented process for withdrawing melted lead from a furnace. If the judge at the trial found that the same method must necessarily be involved in the Karsten furnace, or if he found that the Karsten furnace was not so practically useful for business purposes as the plaintiffs' construction would be, yet that the changes necessary to be made in the Karsten furnace were changes only within the proper province and duty of the experienced smelter wishing to increase the durability and working capacity of his furnace, then he would be bound

to hold that the plaintiffs had failed upon the whole case to establish their right to recover. The judge came to this conclusion and directed a verdict for the defendants accordingly. In pursuing this course he exercised a duty which this court has in many cases approved; and if this court can see that the Karsten description and drawings exhibit an organization which involves the same principle as the plaintiffs' furnace, then all the exceptions of the plaintiffs which are based upon the action taken by the court below in directing a verdict for the defendants, must be overruled.

In support of the position that the description in the text and the accompanying plates of Karsten's treatise shows furnaces for smelting ores operating upon the same principle, as to the withdrawal of clean metal, as the furnace described in the plaintiff's patent, the defendants took the deposition of Dr. John Percy of London, who is well-known as an eminent authority on metallurgical subjects and the author of various standard treatises on metals, and occupies no inferior position in the scientific world. His deposition will be found on pp. 82–87 of the Record. He gives fully the reasons for his conclusion that the Karsten publication, with the accompanying illustrations of a smelting-furnace, fully anticipates the invention set forth in the Keyes & Arents patent; and he answers the seventh cross-interrogatory (p. 85) as follows:

> "After full consideration, I should say that the construction of Karsten's furnace referred to in Exhibit B, is such that it may be worked exactly in the same manner and with the same results as the furnace claimed by the plaintiffs as their invention."

The defendants also have taken the deposition of the English mining engineer and metallurgist, Hilary Bauer-

man. Rec. pp. 87-91. He states, in answer to the sixth interrogatory:

> "I am of opinion that the principle claimed by the patentees is to be found in the blast-furnace illustrated in Fig. 860, Plate 41, of *Karsten's System der Metallurgie*, and described at p. 166 of Vol. V of the text, which work was published at Berlin in 1832."

The defendants also read in evidence the deposition of Prof. John M. Ordway, of the Massachusetts Institute of Technology, who has held the professorship of metallurgy and industrial chemistry since 1869. (Rec. pp. 91-94.) He says, in answer to the tenth interogatory, (p. 93):

> "The furnaces thus figured by Karsten are planned for withdrawing the reduced metal continuously, and as fast as possible, from the oxidizing action of the blast and the intensely-heated part of the slag. So, the metal is made to flow constantly outward and upward through the open eye into the fore-hearth, which is made as high as the inner crucible; and, generally, the clean molten metal alone is passing through this bottom eye. When much slag is formed it is run off separately by another eye placed higher up; when very little slag is produced it accummulates for a long time on the top of the molten metal in the inner crucible, and the clear metal in the fore-bey may be partially removed many times without allowing any of the slag to escape through the eye."

And, again:

> "The drawing of the Keyes & Arents furnace shows a large and cylindrical crucible and an upward slant of the channel; but the action is the same, whatever be the shape or size of the crucible, or the length or direction of the channel, as long as the eye itself is at the bottom."

The Capacity of the Karsten Furnace when constructed according to Karsten's Description, to Exhibit the Principle of the Keyes & Arents Patent.

In order to establish the fact that a Karsten smelting furnace, such as is exhibited at Fig. 860 of Karsten's work, would operate practically in smelting ores, and enable clean metal to be collected in the fore-hearth or exterior basin, free from slag and other impurities, Mr. James Grant, one of the defendants, caused to be constructed a small furnace of seven or eight tons' capacity, according to the drawing, Figs. 858–860, of Karsten's publication. This furnace was worked for the reduction of lead ores for about a week with entire success. (Testimony of James Grant, Rec. p. 38, 39, 52.)

Prof. Bieger, a metallurgist educated at Freiberg, and who has practiced his profession in this country since 1867, and has been in charge of various smelting works in the mining districts, and erected many furnaces in this country, testifies that he examined the working of the trial Karsten furnace erected by Mr. Grant, of which the model in court is a correct representation, and that such furnace worked regularly and made clean slag and clean metal. (Bieger, Rec. pp. 63, 64.)

W. H. James, who is also an educated metallurgist, and general superintendent of the Grant Company, testifies to the successful working of the experimental furnace. (James, Rec. pp. 79, 80.) And finally, Mr. Smith, a practical smelter, testifies to witnessing the operation of the same furnace; and that it was entirely successful in producing clean lead in the lead-basin, and that it worked

upon the same principle in producing clean metal as the Keyes & Arents furnace, with which he is familiar.

None of this testimony as to the practical operation of the Karsten furnace is impeached. Attempts are made to throw a doubt upon the ability of the furnace to do good work, based principally upon the criticisms which have before been noticed. While it was highly proper for the defendants to erect a Karsten furnace to prove practically that it was capable of accomplishing the result which Karsten describes, it was not strictly necessary to do so, for the reason that it is plain that the plaintiffs' patent embraces only that improvement to be applied to a furnace of ordinary construction, which consists in the combination with such ordinary furnace of an exterior receiving basin connected with the lead-well inside the furnace by means of a tube or passage-way, whereby the clean metal at the bottom of the lead-well will rise under the effect of a natural law into the receiving-basin outside the furnace, from which it may be dipped with a ladle.

It is fairly to be assumed that the Karsten publication, describing as it does furnaces which had been actually constructed and put into use for smelting purposes, stated a truth; and when the drawings of such furnaces are given, showing a construction which makes it certain that the lead-well inside the furnace was connected with an exterior basin by means of an eye communicating with the bottom of the lead-well and the bottom of the exterior basin, it needs no practical demonstration to satisfy the intelligence that molten reguline metal which has separated itself from slag and other impurities and settled at the bottom of the lead-well within the furnace, will necessarily pass through the eye into the exterior chamber, and that

so long as the furnace is properly worked, no material of lighter specific gravity than clean lead can by any possibility descend through the reguline metal in the lead-well and pass through the eye leading to the receiving-basin. Such practical demonstration has, however, out of abundant caution, been made. Inasmuch as the genuineness of the publication of Karsten was not disputed, and the priority of such publication to the supposed invention of the plaintiffs not questioned, and the identity of the principle involved in it, as to the method of tapping the furnace, with the method described in the plaintiffs' patent being established, first, from the reading of the Karsten publication and an inspection of the drawings, and, secondly, from the proof of the successful operation of a test furnace built after the drawings, the court was not only justified in not allowing the jury to pass upon any question and run the risk of incurring a second disagreement in the case, but it was its duty to give the direction that a verdict should be returned for the defendants.

BENJ. F. THURSTON,

Of Counsel for the Defendants.

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No. 208. *October Term, 1885.*

Supreme Court of the United States.

KEYES & ARENTS

vs.

JAMES D. GRANT AND JAMES GRANT.

Reply to Brief for Defendants in Error.

GEORGE HARDING,
G. G. SYMES,
FRANCIS T. CHAMBERS.

Allen, Lane & Scott, Printers. Nos. 229 and 231 South Fifth Street, Philadelphia.

Supreme Court of the United States.

Keyes et al.

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No. 208.
October Term, 1885.

REVIEW OF AND REPLY TO THE BRIEF FOR DEFENDANTS IN ERROR.

The Invention.

In the brief filed in behalf of the defendants in error the learned counsel so persistently ignored the objects which the patentees state in their patent that their invention is intended to serve that before reviewing this brief, it will be as well to call attention to the fact that the purpose of the invention was

FIRST.—TO EFFECT AN AUTOMATIC DELIVERY OF CLEAN, PURE METAL FROM THE FURNACE.

SECOND.—TO PREVENT THE FORMATION OF ACCRETIONS IN THE BOTTOM OR CRUCIBLE OF THE FURNACE.

To attain these ends the patentees direct that a lead well or basin should be placed at one side of the furnace, and at an

elevation above the bottom of the crucible, to which it is connected by a tube passing upward from the bottom of the furnace to the bottom of the lead well.

The effect of this arrangement is easily seen, and is fully explained in our brief. If skillfully constructed, as for instance like the furnace shown in the patent drawing, it is *impossible* for anything but pure clean lead to be forced up into the elevated lead well, and clearly this clean product will automatically appear there as rapidly as it is formed.

It is also evident that in such a furnace there is a level considerably above the bottom of the furnace, below which nothing lighter than lead can penetrate, and hence no slag, matte, or raw ore, the substances from which "sows" or accretions form, can come in contact with the bottom of the furnace. But besides this, the constant stratum of lead acts to prevent the sudden falling of the charge in the furnace below the influence of the blast, and hence there is not only no danger of "sows" attaching themselves to the furnace bottom, but the danger of the formation of loose "sows" is greatly lessened.

The Furnace as it was before Patentee's Improvement.

In *pages 3 and 4* of the defendants' brief they describe the furnace to which the plaintiff's improvement is attached, and they very accurately describe it as being what their great authority, *Karsten*, calls "*a shaft furnace with a closed breast*" (see page 13 of their brief), in which the operation of smelting was carried on, until a mass of molten metal, matte, and slag had accumulated in the closed crucible, which was then *tapped* or perforated at the bottom and the metal and matter *all* allowed to run out into a receptacle placed *below* the furnace, after which the tap-hole was again plugged and the crucible allowed to refill itself.

That this furnace and this method of obtaining the metal bore no resemblance to the improved furnace and method, and that none of the advantages sought by the patentees existed or could exist in it is self evident.

Erroneous Definitions.

The definitions and explanations furnished in *pages 4 to 5* of defendants' brief are in part absolutely without justification; thus, the statement (p. 3) that in smelting the lead melts first, then the slag, &c., which would give the idea of an orderly procession of lead followed by slag, while as a matter of course these two materials together with the matte are constantly running down together. Again, the pressure of the blast is given as equal to one inch of lead, whereas it is equal to an inch of mercury, a much heavier metal. (*See p. 111.*)

Again, on page 4, "fore-hearth" and "lead well" are referred to as having the same meaning, and as being "the exterior basin into which the molten lead flows from the furnace" which is an accurate definition of a lead well, but does not define a fore-hearth or foresumph: First, because it is *a part of the furnace crucible* and not an "exterior basin." (See Karsten, defendant's brief, page 14.)

Second, because wherever a fore-hearth existed in a furnace its function and object was to receive not the "molten lead," but the whole molten mass of lead, matte, and slag formed in smelting. (See Karsten, pages 318, 319, and 320, defendant's brief, pages 14 and 15.)

Inaccurate References to Alleged Prior Publication.

Having now adroitly laid the foundations of their case by confusing the meaning of technical words, in *pages 5 to 6* the counsel next refer to a furnace "used" in 1831–2, and give an account of its mode of operation when in use, whereas in fact the testimony of *all* the witnesses proves that no such furnace ever was used, even their own, referring to it as "an ideal furnace," and the nearest approach to it being without the feature on which they hang their whole theory of defence, viz., the slag eye. In these pages of the brief also, what the author Karsten says about this "ideal furnace," and what the defendant's witnesses say about it, is inextricably mixed up, so that the author is apparently made to offer an explanation as to why he did not invent the Keyes & Arents furnace, whereas in fact, no expla-

nation is given or required as to the reason why he used a fore-hearth furnace as such, and did not improve it into a Keyes & Arents furnace.

State of the Art.

This section of the brief terminates at the bottom of page 6, by the triumphant assertion that *basins were old, tubes were old, and furnaces were old*, and that fluids had been "*balanced*" by means of the same law utilized by the patentees. Hence, apparently, we are to at once conclude that there would be no invention in so combining these old things, as to produce a furnace which for the first time in the art automatically delivered pure metal, and protected itself against the formation of sows.

SECTION II.

The Tea-pot as an Anticipation.

The second section of defendants' brief (*pages 7 to 12*), professes to be an argument as to the question of patentable novelty. The first point made is that the *syphon* and the *tea-pot* being old there was nothing left to be invented in any combination of tubes and containing vessels. Why the syphon is brought into this argument is not explained, since nothing exists in the patented lead furnace which partakes in the least degree of the nature of a syphon.

The *tea-pot* is we truly believe quite as close an approach to our invention as anything else referred to by the defendants in error and hence may well have the position of precedence given it in the brief.

A vivid imagination might picture Keyes & Arents gazing at a *tea-pot*, like the familiar picture of the youthful Watt lost in contemplation of his mother's tea-kettle; and evolving from the study of the reason why a tea-pot did not overflow, the idea of an automatic delivery of clean lead from a lead furnace; but it has never been held that Watt stole the invention of the steam engine from the historic tea-kettle, yet

it would be just as reasonable to condemn Watt's invention on this ground as to invalidate this furnace patent, because of the prior existence of a tea-pot.

Patentability.

The defendants' counsel next attacks the patentability of the invention for the reason that the product of the furnace, to wit, *clean lead*, was not a new article of manufacture. This would be a sound position if the patentees had claimed clean lead as their invention, and the cases cited in page 8 would be in point if these defendants had shown that a furnace structure such as described in the patent had been used before Keyes & Arents' invention to effect the automatic delivery of clean metal or its equivalent into a well and to prevent the formation of accretions.

None of them, however, come quite up to the defendants' conclusion that a *tea-pot* can be an anticipation of an automatic self protecting lead furnace.

Utility.

The balance of section II. (*pages 9 to 12*) is mainly an attack on the utility and value of the patented furnace. It is hardly worth while to point out the testimony which establishes this value since the court will not be likely to believe that these defendants are pushing this contest for a perfectly worthless device. The testimony of Grant and Geist as to the *possibility* of getting slag into the automatic lead well, if your Honors will look at it it will be seen to be conditioned on a change in the elevation of the well as shown, and the character of the passage leading to it. In short, they seem to have constructed the furnace unskillfully for the purpose of making this point, and even then the slag could only get out into the basin because of gross carelessness or deliberate intent on the part of the furnace man. That this evidently could happen in a properly built furnace is simply *impossible*, and that it was likely to happen in any furnace built to carry out the patented method is in the highest degree improbable.

The idea which counsel seem to entertain, that by sinking the bottom of the furnace below the lead exit passage this would be prevented (page 11), discloses a confusion of ideas about the "*principles*" which they make so much of which goes far to establish their good faith in the line of defence adopted, since it makes it evident that they have not at any time understood the laws upon which the patented furnace works in spite of their study of the tea-pot.

Section III.

Karsten Mistranslated.

Pages 12 to 16 of the brief are chiefly taken up by a reprint of the translation from Karsten, to which, however, they add two pages, 316 and 317 (brief, pages 12 and 13), which are not included in the transcript. As to the balance, it is a deliberate attempt to make Karsten say what he did not say; in short it is a mutilated and inaccurate translation carefully adapted to the exigencies of the defendants' case, and in essential features materially misrepresenting the author's meaning.

The true translation of Karsten, pages 318, 319 and 320 are to be found in the supplemental transcript, pages 7 to 10, and for convenience of comparison we have printed the two translations in parallel columns.

An examination of these columns will show that defendants had two objects to serve by mistranslating Karsten.

First.—By translating "*regulinesche metall*," on pages 319 and 320 of Karsten "*clean metal*" they sought to give the idea that Karsten contemplated the presence of pure or clean lead in the fore-hearths of his furnaces, whereas, in fact nothing of the kind is suggested, the expression meaning in German just what it does in English, viz., "Reguline metal," as distinguished from metal in *chemical* combination with other substances, such, for instance, as copper or lead metal, which some smelting operations result in, while others produce reguline metal.

Second.—The furnaces with a fore-hearth which Karsten describes, and on which the defendants rely, and which they say was clearly adapted to carry out the patented process of automatically delivering clean lead. Of these furnaces Karsten says (page 320) that they are closely analogous to a *channel furnace*; and of a channel furnace he says: "THEY WOULD BE ESPECIALLY IMPRACTICABLE IN THE SMELTING OF LEAD ORES," and are not adapted for smelting operations where reguline metals are to be produced, but only for the production of mattes. (See sup. trans. of record, page 9.) The whole of this section the defendants deliberately omit from their translation; and this omission indicates a full appreciation of the bearing of the passage upon their case.

Misleading reference to Keyes' Testimony.

On *pages 16 to 19* of the brief, there is printed what purports to be, and is referred to as, the testimony of Mr. Keyes. As to this we wish first to call the court's attention to the fact,

First.—That *it is not correctly copied from the record.*

Second.—It is NOT Mr. Keyes' testimony but was put to him as a question (the whole of it) he being asked *if* he so testified at the former trial. What the paper was from which counsel read does not appear, nor is there any explanation as to the general tenor of the examination of which this is alleged to form a part. The witness answered that he does not remember having so testified that the slag hole and the conditions of the parts were different (page 146), and defendants' counsel simply drops the subject without attempting to prove that Mr. Keyes had testified as it is now claimed he did.

Percy's Testimony.

On *pages 19 to 21* the testimony of Percy is quoted at length. This gentleman had never seen either a Karsten or a Keyes & Arents furnace, and begins his testimony by assuming that the lead in the basin or fore-hearth will be at the "*same level*" as in the furnace. This can only be so when

both receptacles have also slag chambers of equal height, and can never therefore be true of the elevated basin.

Beginning, however, with this fundamental blunder, Professor Percy is inclined to think that "*by suitable management*" slag and matte "*might be*" prevented from entering the Karsten fore-hearth, but winds up this expression of opinion by saying that they wouldn't do any harm anyhow, as they would not injure the "*quality*" of the lead. In short the lead might be cleaned by some of the old ways *after* it got out of the furnace.

As to the operation of the patented process in preventing the formation of "sows" he says nothing.

Simplicity of Patentees' Invention.

Pages 21 and 25 of the brief are devoted to showing how easily a Karsten furnace might be altered to a Keyes & Arents furnace, and we are not disposed to dispute the proposition, that if a man has a fore-sumph furnace and wants to change it to a Keyes & Arents furnace, he can do so without difficulty. But if he undertakes to change the fore-hearth into an automatic lead well by elevating it and correspondingly elevating and changing the position of the slag eye, he changes the whole character of the structure, for his furnace ceases to be an open-breasted one and becomes, as the defendants' brief explains (page 2), a shaft or closed crucible furnace.

It would seem that the whole of this part of the argument is founded on the conviction that invention is impossible without complexity, and hence the simplicity of the patentees' device must be fatal to their patent.

In pages 22 and 23 counsel refer with emphasis to the fact that Mr. Arents states in the record that he had seen a furnace similar to Karsten's at work in Germany, and that as therein used it had no slag eye, so that the whole molten contents of the furnace passed through the covered eye into the fore-hearth, which they say "is the very case mentioned by Karsten." Anything more unlike the patented method would

be hard to think of. Indeed the mere fact that a furnace could be so used would seem sufficient to show that it could not be a Keyes & Arents furnace.

Grant Experimental Furnace.

We must call the particular attention of the court to the concluding paragraph of the defendants' brief, *pages 25 and 26.* Two distinct and most material misstatements are embodied in these two pages.

First.—It is stated that the defendants' experimental furnace was a Karsten furnace. We have pointed out in our brief that this Grant furnace does not even pretend to be like Karsten's in any particulars other than in its central side elevation, and we have now to call attention to the fact that even in this respect this furnace did not follow the drawing Fig. 860. A comparison of the drawings from Karsten's plate XLI. with the drawings of the "Defendants' Model" will show that in Grant's furnace (*a*) the fore-hearth was higher, (*b*) the fore-hearth was wider, (*c*) the forward pitch of the inner hearth was not so great, (*d*) the slag eye was higher, (*e*) the slag eye was in a different place, (*f*) the breadth of the inner crucible was from two to three times as great. Every one of these changes was adapted to improve the chances of getting *this* "Karsten" furnace to deliver clean lead in its fore-hearth, and it becomes apparent that besides the careful management admittedly necessary to work it, there was careful and ingenious management in the getting of it ready to work.

It is not necessary to explain how the elevation of the fore-hearth, the change in the slag eye, and the deepening of the inner hearth aided in keeping the slag away from the closed eye. But it may not be so clear as to how the broadening of the inner and outer crucible assisted in this function. Yet it is simple enough. The whole area of the furnace was more than doubled, and if the dipping of a hundred pounds of lead from the Karsten fore-hearth would lower the lead level by two inches, the removal of the same quantity from the Grant

"Karsten" furnace would lower the level by less than one inch, and hence the slag would be much less likely to get into the covered eye.

Second.—Counsel state that the Grant "Karsten" furnace was used continuously for from sixty to ninety days. This is an entire mistake. All that Grant claims for it is that he experimented with it during one week, and by careful management was able to get the metal into the fore-hearth with very little slag. (Grant, pages 38–9 and 52–3.)

The furnace, of which Grant says that it was in use for sixty to ninety days, was one of his regular Keyes & Arents furnaces, to which in addition to the inclined tube he had added a second horizontal tube leading into a second lead well of the same height as one connected with the inclined tube, and the point to be demonstrated was simply that the lead would stand at the same height in both basins, a fact which hardly needed demonstration. The mere fact that this furnace could have *both* an inclined and a horizontal tube demonstrates that it could not have been either a genuine or a "carefully managed" Karsten furnace, and Mr. Grant does not pretend that it was.

Grant, pages 40 and 61.

Geo. Harding
G. G. Symes
Francis T. Chamber

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IN THE

Supreme Court of the United States,

OCTOBER TERM, 1885.

NO. 208.

WINFIELD SCOTT KEYS AND ALBERT ARENTS,
Plaintiffs in Error.

vs.

JAMES B. GRANT AND JAMES GRANT,
Defendants in Error.

ARGUMENT FOR DEFENDANTS IN ERROR,

By WHIT. M. GRANT.

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ARGUMENT FOR DEFENDANTS IN ERROR,

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The main question before this court is:

Did the court below properly decide that there was no question for the jury to pass upon, and that on the whole evidence there must in law be a verdict for the defendants.

Two propositions may be involved in determining this question:

First. Was the case such an one that the court below, by a mere comparison of the device patented and the device described, decide upon their identity without evidence to explain terms of art.

Second. Would the court have granted a new trial if the verdict had been against the defendant?

Before discussing this question, perhaps, we may describe the state of the art of smelting lead or other ores in blast furnaces, at the date of the plaintiffs' patent, and at the date of the alleged piracy of defendants, November, 1871, and September, 1878. A blast furnace for melting ore is a shaft-furnace, tubular or rectangular, of various diameter and height, from fifteen to eighty-five inches for lead, and ten to fifteen feet for iron, and of the height of fourteen to eighteen feet for lead, and as high as one hundred feet for iron.

All blast furnaces have to be made of the strongest fire resistant materials. In Europe, at the date of Karsten's work, so often referred to, the bottom of a lead furnace was made with brasque, a French word (Wates' Chemical Dictionary) for mortar made of fire clay and powdered charcoal or coke. At Eureka, Nevada, the furnace was made of a peculiar kind of stone, which resisted well the action of fire heat. In Utah and Colorado, and probably in California, the part most subject to the heat was made of an iron water-jacket, cast or wrought, with a hollow chamber through which cold water was constantly flowing to prevent the melting of the inside wall. This improvement was introduced by Piltz, at Freiberg, Saxony, about 1865, and is followed everywhere, except at Eureka.

In this mode, the lead furnace is composed of three parts: The bottom, called "sump," defined in Webster's Dictionary: "a round pile of stone for receiving the melted metal;" or, "a crucible," defined by Webster to mean the same as sump; or, called in this country and Europe, a "hearth." This bottom part, which is about fourteen inches deep in the small furnace described by Karsten, was in defendants' furnaces, and most others, about thirty to thirty-six inches deep. It is made of resisting stone at Eureka, but elsewhere of fire-brick and fire-clay and charcoal mortars. On the top of the sump, or crucible, or hearth, about four feet high, a water-jacket of double iron (in round furnaces like a steamboat boiler), with a small hearth or opening, at the front or some

other convenient point, of the furnace for a slag spout is placed, and on the top of this a brick enclosure to the top of the furnace with side doors near the top for feeding the ore, fuel, and flux, into the furnace; a chimney covered all. The sump, or crucible, has near the bottom an eye or opening for tapping or draining off the clean metal, which by its superior gravity, settles at the bottom; at the date of the plaintiffs' patent this opening or eye was closed with a plug of clay, and the melted metal tapped, as occasion required, into a lead-well or basin built by the side of the sump, or crucible.

Near the top of the sump, and just above it, and in water-jacket furnaces, near the bottom of the jackets, are placed a number — sometimes six or eight — of tuyeres or blow holes, to admit air from blowers working on the principle of a fanning-mill instead of a bellows, by which the air is concentrated and forced through small tubes directly on the ore, flux, and fuel, to melt the same; the number of these tuyeres or blow holes depends on the diameter of the furnace and the heat to be obtained, which in all lead furnaces must be as high as 2700 degrees of Fahrenheit, to melt the iron flux.

At the front, or some other convenient point, of all these furnaces, is an opening or eye to draw of the slag, or dross (Webster's dictionary), or waste materials, with a spout to the outside of the furnace, in which it flows to a slag or dross-pot mounted on wheels, by which it is carried to a distance and emptied while fluent. The slag-eye or opening is closed, except at stated intervals, with a plug of clay, and opened by striking with an iron rod. As the flux and dross, called slag, is from five to eight times the weight of the good metal, the slag-spout has to be opened every fifteen minutes, and closed by the clay plug as soon as the slag is reduced to a proper level in the furnace. The model of a modern furnace, filed by the plaintiffs, as well as the drawing to his patent, omits this slag eye or spout (See pages 27 and 29), and we shall fully supply that omission by our working models before the court.

The openings shown in their engravings are the tuyeres or blow holes.

At the date of the plaintiffs' patent, the lead-well or basin, or vessel to receive the good metal, had not been used for the metal to flow out continuously except at mine La Motte, in Missouri, in the United States (see Bauermans testimony in full, page 87), but it had been used in Europe, in Corinthia, China, and France, as seen by Bieger and Bauerman. (See their evidence, pages 87 and 62.) Bauerman says, reciting history, that it had been used in France for iron ores as early as 1765.

The use of it in Europe is proper proof to show the history of the art only. The use of it in America, at mine La Motte, is sufficient to defeat the plaintiff's claim to a patent.

The patented claim, and the description in Karsten's System der Metallurgie, plate 41, figure 860, show that the connection between the sump or crucible of the furnace and the lead-well or receiving vessel on the outside starts from the bottom; but the defendants' furnace (see Bauerman's evidence, page 87, and Grant's) placed this connecting opening about fourteen inches above the bottom, so as always to keep a supply of melted metal as a hot bath in the sump or crucible, and to keep the bottom clean.

The plaintiffs' patent shows a connecting tube of iron; the description in Karsten covers the connecting eye or opening with brasque. The defendants' furnaces have the opening about fourteen inches from the bottom (see Grant's evidence), and the lead is drawn from the furnaces in Grant's smelting works through a passage moulded in the substance of an addition to the furnace, representing the forehearth, and not through a tube of iron, clay, or other material like that marked "C" in the specification of Keyes & Arents patent (see Bauerman's evidence, page 89) answer to first cross interrogatory.

We have elsewhere shown that all the terms applied to the shaft or blast furnace are defined in Webster's Dictionary. Other words used by the witnesses in relation to the subject are not common, but require no expert evidence; as: Speiss, mixed arsenic and nickel (Webster); Matte, unrefined metal (Webster); Regulus, pure metal (Webster).

STATEMENT OF THE CASE.

In November, 1871, the plaintiffs procured letters patent for an improvement in smelting furnaces, claimed to have been invented by them, which consists in a lead-well or basin located at a suitable elevation above the bottom of the furnace, and on one side of it, and connected with the bottom of the furnace by a round tube about three inches in diameter, leading into the bottom of said basin. (See drawing record, page 28.) The object of which is to procure clean metal in said basin or lead-well seperated from the slag and other molten masses. It is said in the discription, in the patent that this device will also prevent the formation of incrustations or matte on the bottom and sides of the furnace by keeping the bottom of the furnace or crucible covered with molten metal; but the claim in the patent does not cover such, and the evidence shows that it does not accomplish that result.

The defendants claim that this patent is invalid, because the device covered by it was described and illustrated in a printed publication in a foreign country, to-wit:

Karsten's System of Metallurgy, published in 1831-2, Vol. III., pp. 317 to 320, and Vol. V., p. 166, and figure No. 860 of plates, the latter of which is shown at record, p., 38.

Taking the drawing and description from above, the defendant, J. B. Grant, constructed the furnace described and shown, which worked upon the same principle, produced the same result, and in the same manner as was accomplished by plaintiffs' device — clean metal in the lead-well, free from slag and other impurities. The slag being passed off over the lead-well, where a thin crust was formed and thrown off to dip out clean metal, or slag was run over the lead-well by means of a sheet-iron gutter, or around it by a channel, or from some other part of the furnace than over the lead-well.

The location of the lead-well and slag-hole being no part of the description of the furnace, may be placed at any point in its circumference to suit the convenience of the smelter, builder, or worker.

The plaintiffs claimed that this furnace described in Karsten's, was constructed for other purposes, and that it would not work at all, because the open eye connecting the crucible with the lead-well was too large, and the contents of the furnace would blow out through the lead-well, and that the partition between them was made of brasque, a perishable material, and would not last, and the weight of the molten mass would blow it out, and the same result follow as above; and that the lead-well was set too low, and when the metal was dipped out there was no lead bath left in the bottom of the furnace, and matte and speiss would form on the bottom and stop the furnace, and that the space between the slag-eye and hidden eye or lead-well eye was to short, and slag-eye was to large, and if kept running would blow the furnace out and cool it off so it would not work; and that if kept running by reducing size of hole even, the slag, according to description, was to pass over the lead-well, and they could not be worked at the same time; and finally, that this kind of furnace was intended to work by making the lead-well, an outside opening, into the inner well or crucible, and the molten masses intermixed promiscuously, and the metal could only be removed by dipping it out through the slag, more or less of which adhered to it, and hence it could not be produced as clean metal. They had, however, never seen or built such a furnace.

Against this, the defendants present the fact that such a furnace was built and worked, was not open to the objection raised, and produced clean metal, and the open eye is not larger than the tube in plaintiffs' patent — three to three and a half inches in diameter. That the partition was made of brasque in Karsten's time because they did not have ore to smelt constantly and did not need or build furnaces permanent; and that in later years they used fire-brick for such work, and their substitution for brasque made it permanent and it did not burn or blow out. That the lead-well was set low and the bottom of the furnace shaped differently for same reason.

There was not much ore. It was brought in by spells and in small quantities. Consequently furnaces were made smaller, and everything else to correspond, so they could be run a short time and be easily cleaned out when through. And it was never necessary

to draw all the metal from the furnace, whatever its size; and the lead bath could be left in a small as well as a large furnace, and could all be forced out through the plaintiffs' device, and to avoid which defendants set the opening to the lead-well in their furnaces, about fourteen inches from the bottom. And that the lead bath in the bottom of the furnace was due to the old Scotch ore-hearth process, used long before plaintiffs' suppose discovery, and that the formation of incrustations were avoided by other means and in no way connected with the withdrawal of the metal, and the space between the slag-eye and open eye were in proportion to capacity of furnace. That the kind of ores smelted then were of such character that the slag could be allowed to flow, and that the molten masses did not mix indiscriminately in the outside lead-well, as supposed, and that the slag-spout was put over the lead-well because when the slag ran over the metal a thin crust formed, and the Germans did it because they thought it prevented the oxidization of the lead; and again, small shots of lead remained in the slag and fell into the lead-well as the slag passed over, and were saved.

And further, that it required not inventive genius, but only ordinary business tact, as the business might require, to make the open eye smaller if too large; to make the partition of fire-brick if brasque was too perishable and weak; to raise the lead-well if too low; to increase the space between the open and slag eye-and raise the tuyeres if too low, and to increase size of furnace if too small, and close slag-eye if slag was not made fast enough to keep it in use, and make it smaller if too large; and set slag-eye or lead-well to one side or use a sheet-iron or similar trough or channel to bridge slag over lead-well if you did not want it to pass over and form the crust.

That the construction of a working furnace is not the question at issue; but after a working furnace is built, whether the metal can be gotten out in a clean state. It is conceded it can be done by plaintiffs' device, but we insist that it is done upon the same principle and in the same way as described by Karsten, in his book published in 1831–2, above referred to; and the trial made by defendants proved this identity.

That this same process was used in iron furnaces in 1765, and in other metallic furnaces in Corinthia, England, and America, before plaintiffs' invention.

That the same thing was used at mine La Motte, Mo., prior to plaintiffs invention, and in the spring of 1871.

Upon this state of facts, and from an inspection of the descriptions, models, and plates of the two devices, the court instructed the jury to return a verdict for the defendants.

ARGUMENT.

I.

The court should instruct the jury to return a verdict for either party, when the evidence is of such conclusive character that any other verdict the court would, in the exercise of sound, legal discretion, be compelled to set aside.

Herbert vs. *Butler*, 97 U. S., 319;
County of Macon vs. *Shores*, 97 U. S., 272;
Orleans vs. *Platt*, 99 U. S., 676;
Griggs vs. *Houston*, 104 U. S., 553;
Heald vs. *Rice*, 104 U. S., 737;
Insurance Company vs. *Doster*, 106 U. S., 30-2;
Arthur vs. *Jacoby*, 103 U. S., 677;
Pence vs. *Langdon*, 99 U. S., 578–80;
Mont Clair vs. *Dana*, 107 U. S., 162;
Bank vs. *Insurance Company*, 103 U. S., 783.

Or the court may instruct the jury to return a verdict where the evidence, with all the inferences that the jury could justifiably draw from it, is insufficient to support any other verdict.

Pleasants vs. *Fant*, 22 Wal., 116;
Bowditch vs. *Boston*, 101 U. S., 16;
Randall vs. *B. & O. R. R. Co.*, 109 U. S., 478.

This is true in patent cases, as well as others, notwithstanding

what was said by the court in *Tucker* vs. *Spaulding* (13 Wal., 543); *Bischoff* vs. *Wethered* (9 Wal., 812);

Heald vs. *Rice*, 104 U. S., 737.

II.

This case comes within these rules: Because it must be be apparent to the court from an inspection of the drawings and description of the two devices that the principle of their operation is the same, to-wit: The hydrostatic principle of communicating vessel (plaintiffs' device, drawing, record, p. 27, and Karsten's, p. 39).

In an ordinary shaft furnace, such as described by Karsten and to which plaintiffs' device is attached, the ore and fuel are placed in the top of the furnace, and as the heat melts the whole mass the good metals, being heavier, sink to the bottom of the sump or crucible, and there they remain separated from the slag or refuse of the molten mass, which remains above the metal.

Now then, you have your metal in the bottom of the sump or crucible, separated from the slag; how can it be gotten out in a clean state? According to Karsten:

[See figure 860, plate 41, and Vol. III., p. 320, and Vol. V., p. 166, record, pp. 36, 39, 41, 42, 48, 50, 51. (Karsten and the translation were left out of the record, and we have referred here to the quotations made by Mr. Grant in his evidence, the material part of which is as follows):

Karsten, Vol. III., page 318: "Sumph furnaces are shaft furnaces in which the hearth (or crucible) is partly on the inside and partly in front of the furnace. The slag runs *over* the fore-hearth, and the matte and metal are tapped off into a tap basin Sumph furnaces are not always provided with tap basins, and the metal is then dipped with ladles from the fore hearth."

Karsten, Vol. III, page 320: "Figure 475 to 475 represents a symph furnace with a covered eye in which the brasque (a mixture of fire-clay and coke dust) under the front wall divides the sumph (hearth or crucible) into *two communicating vessels.* The slag runs off through the eye between the bottom of the front wall of the furnace and the top of the brasque partition. *This arrangement is*

used when one wishes to dip the clean metal with ladles from the fore-hearth, instead of tapping it off from the hearth *into receiving basins.*"

Karsten, Vol. V., page 166: "Figure 860 represents a vertical section through the tuyere. Figure 859 represents a front view of the furnace. The tuyere is placed fourteen inches above the horizontal surface of the fore-hearth. The height of the shaft from the tuyere to the fuel door is forty-four inches. The inclination of the walls can be seen from the drawings. The shaft is of uniform breadth from the front to the back. The depth from the tuyere to the front wall is forty-two inches."]

by means of the lead-well connected with the bottom of the crucible by an opening (which is about, as the evidence shows, three inches in diameter), or — which is the same thing — a partition in the crucible, one part in and the other outside of the furnace; with this opening between, called by him "hidden eye" (so called because covered by the metal when furnace is at work), from which outside partition or lead-well the metal may be tapped off or dipped out. (Record, pages 36, 41, 100).

The court will observe that no detailed or minute description is given. On pp. 318 and 320, Vol. III., he simply describes what a sump furnace is; how the slag, matte, and metal may be withdrawn, and illustrates with rough cuts, on which he designates the different parts; and on p. 166, Vol. V., he deals with furnaces actually used; gives dimensions of the different parts. It is a sump furnace described in Vol. III., pp. 318 and 320, above the rough cuts of which are shown at figures 473 to 475, so that any smelter seeing figure 60 knows it is a sump furnace, and knows at once how to build it, and ought to know how it will work; and any man can see that its principle of operation is identical with plaintiffs' device.

Plaintiffs' say the removal is by means of a lead-well located on the outside of the furnace, at a suitable elevation above the bottom of it, and connected by a tube (which is about three inches in diameter, as the evidence shows) running from the bottom of the furnace to the bottom of the lead-well, from which the metal may be removed — tapped or withdrawn (pp. 27 and 28).

The removal is accomplished in both cases in the same way, and by use of the principle of communicating vessels, the metal rising to the same height, or a little higher in the outside basin than it does in the crucible, by means of force or pressure of the tuyeres or blow-pipes, added to the weight of the slag and charge.

In *Heald* vs. *Rice*, 104 U. S. 737, this court says that the identity of the invention in the original and reissued letters patent is to be determined from their face by mere comparison; and on p. 749: "That is, if it appears from the face of the instruments that extrinsic evidence is not needed to explain terms of art, or to apply the descriptions to the subject matter, so that the court is able from mere comparison to say what is the invention described in each, and to affirm from such mere comparison that the inventions are not the same, but different, then the question of identity is one of pure construction, and not of evidence, and consequently is matter of law for the court, without any auxiliary matter of fact to be passed upon by a jury, if the action be at law."

That same principle is applicable to this case. There can be no distinction, for the purpose of comparison, between the diagrams and descriptions in letters patent and in a printed publication, and the court can see that they *are* as well as that they are *not* the same. Extrinsic evidence is not needed to explain terms of art or to apply the description to the subject matter. It is true, plaintiffs' device shows no method of removing the slag from the furnace, but the slag does not figure in their claim, and it should not be considered by the court. The question is as to the removal of clean metal. Is it not apparent to the court that these two devices operate upon the same principle, and produce the same result; that the metal will rise to the same level in the outside basin as it is in the crucible — in both alike? Nothing can be plainer. The court can see that — as appears by the diagrams — the same amount of metal will not remain in the bottom of the Karsten's furnace as in plaintiffs'; but that is a question of degree or quantity, and not kind; and there is no stated length provided for the tube connecting their lead-well and crucible, and it can be set down on, or nearly on, a level with the bottom of the crucible, and the principle of operation and the result produced will be the same; and so, if need be,

the hearth can be raised and the lead-well deepened in the Karsten's furnace so as to increase the depth of metal in the furnace; and its principle of operation and result produced will not be altered in the least, and all the metal can be forced out of the furnace by plaintiffs' device, if canal is set at the bottom, as they say. Defendants avoid this by putting it about fourteen inches above the bottom. This is as much an invention as plaintiffs' device, and more useful.

If the court will consider the state of the art — the size and other requirements of a furnace — in Karsten's time, fifty years ago, will it not be apparent that it fulfilled all the requirements of its time; and that if a larger furnace and more work had been required, the business *sense* and not the inventive genius of the smelter would have suggested raising the lead-well and increasing all the other necessary dimensions of the furnace to increase its capacity, just as any manufacturer starting in business on small capital would increase the capacity of his works as increased trade demanded? So if you desired to remove and preserve water from beneath oil in a quart bottle by means of a siphon tap or any connecting tube from the filled to an empty vessel, the principle would be the same, only the capacity increased if you desired to do the same thing with a barrel, hogshead, or tank. The only difference, is the capacity of the instruments would be increased, not from the inventive genius but the business sense of the workman.

Of course I understand that in the siphon tap the receiving vessel must be on a lower level than the discharging one; but in case of the connecting tube, the liquid seeks its own level. But the illustration is the same in either case; nor would the principle be different were it desired to remove any other liquid by the same means. No inventive genius would be called into play, nor would it make any difference whether the liquid to be drawn off was at the bottom or top of those in the vessel.

The length of the tube or opening connecting the vessels can have no earthly effect upon the principle, and the only result in

practice is that if too long and too far removed from the furnace, the metal would chill in and close it up, and thus stop its work.

But if that result would follow with a length of four feet, it would not be a patentable invention to shorten it up to a point where metal would not chill.

Hence we contend that from a mere inspection of the two descriptions and diagrams the court must find that plaintiffs' device is not patentable. There is no evidence as to when plaintiffs made their discovery, and the presumption is that it was about the date of their patent, November 28th, 1871.

Karsten's was published in 1831–2, and was on sale in book stores in the United States in 1870 (Prof. J. M. Ordway, Record, page 92), and in Germany since 1838 (Prof. Bieger, Record, page 64), and in 1854 (H. Bauerman, Record, page 89), and in Europe prior to 1871 (Prof. John Percey, Record, page 83).

I say this much because so much has been said as to whether Karsten's furnace would work; I care not whether it would or not. If his lead-well on any other furnace would, that is sufficent; and it is really the only question in the case.

III.

In cases of expert evidence (and plaintiffs' evidence is all expert), this principle is laid down in Curtis on Patents; where it is said that a scientific witness may be asked his opinion as to whether a particular machine is new in its structure or mode of operation, or whether it is substantially the same thing as another, with only apparent differences of form and structure.

But when the differences or resemblances have been pointed out, and when the view that science takes of their relative importance has been ascertained, etc., the court must instruct the jury whether the particular change amounts, in point of law, to a change of what is commonly called the principle of the machine. The most scientific witness can only say what in his opinion are the differences or resemblances between one machine and another, but the question of what constitutes a fresh invention, or what upon a given state of facts

amounts to a change so great as to support an independant patent, is a question of law, and for the court.

Curtis, fourth edition, sec. 490, p. 648, and cases, note 1.

Hence, if this court should be of the opinion that it could not determine the identity of the two devices from the descriptions and diagrams, we insist that the evidence, with all the inferences to be justifiably drawn from it, is so conclusive that no other verdict should be sustained.

To examine this question makes it necessary to look considerably into the evidence.

What do plaintiffs claim by their invention?

"The method of tapping or withdrawing molten lead or other metals from a smelting furnace by means of the basin B and tube or connection C, in combination with the furnace, substantially as shown and described." See claim in letters patent, (Record, p. 28), diagram, (p. 27).

In the description on p. 27, the method by which the result claimed is arrived at is by setting the basin a short distance from one side of the furnace and a suitable elevation above the bottom of the furnace, and connected by a tube extending from the bottom of the basin to the bottom of the furnace, so that as the molten metal fills the bottom of the furnace it rises to the same elevation in the basin, whence it is removed as clean metal.

Observe the basin is set a short distance from one side. No explanation is given for this; but the fact is, that it is done because it had been customary in this country to have the slag-hole for withdrawal of the refuse from the furnace in front of the furnace and just over the basin or lead-well, so that the slag, unless guided over by means of a trough, or around by means of a channel, ran over the clean metal and formed a thin sheet, which had to be removed when it was desired to dip out clean metal, but which did not interfere if the metal was removed by tapping.

Plaintiff Arents claims in his evidence that it is a part of the art of furnace-building to put the slag-hole in front; (pp. 29 and 103) but evidence of J. B. Grant shows it was in the back in Freiberg, in 1876; (p. 37.) It is in the back of the Colorado smelters, (Geist, p. 74). The American smelter sets the slag spout to one side of lead-well. (Evidence of Mr. Smith, Record, p. 69), and about all witnesses say it may be put anywhere.

Then, by their invention, clean metal was to be obtained by setting the lead-well on the side of the furnace, according to the patent, or to one side of the slag exit, according to the testimony of plaintiff Arents, (Record, p. 29). That is the extent of the claim but since the first trial of this case other wonderful results have been attributed to it. The plaintiffs have assumed that it was a necessary part of the construction of a furnace that the slag-hole should be on the front of it, and have made no mention of it or reference to it in their patent or diagram (Record, p. 27), or diagrams claiming to show the state of the art at the date of their invention and old Karsten's furnace (Record, p. 29); and were evidently thereby misled into the belief that they had made a discovery. This assumption is erroneous. The removal of the lead-well from under the slag-hole evinces business tact, and is the only virtue of the supposed discovery; but it does not possess the merit of inventive genius.

The patent is of course *prima facie* evidence of the novelty of the invention, and this position is not materially strengthened by the testimony of plaintiffs' sixteen expert witnesses (on pp. 30, 31, and 32, Record).

At the trial, plaintiff claimed, as some of the advantages of their invention, that it prevented the formation of incrustations on the bottom of the furnace, composed of unfused ores, speiss, matte (known as sows), and slag, which frequently collected from the old mode of tapping (bottom Record, p. 29; testimony of Arents); lessened accident by fire and danger to life and health; saving in time and labor; the automatic obtaining of clean metal upon the principle of communicating vessels (testimony of plaintiff Arents, Record, p. 30).

We submit that the only claim made in the patent is as to the automatic obtaining of clean lead and other metals, and by claiming this they disclaim everything else.

Corn Planter Patent, 23 Wallace, 181.

The only other advantage even mentioned is the prevention of incrustations, and this is a mere result of their process, and could not be covered by the patent in its present form, even if it were shown to accomplish that result. In fact, it does not.

The defendants having the burden of proof, introduced in evidence the printed publication by Karsten herein before referred to, and by the testimony of defendant J. B. Grant, who is an educated and experienced metallurgist (Record, p. 33), and testified that there is a description of a furnace that, so far as the withdrawal of metal is concerned, worked in the same way, on the same principle, and could be made to produce the same result (p. 38); and that the description of that furnace gives the dimensions. This particular description represents an ideal sump furnace — this furnace. This particular furnace is built from a model in the book (defendants' model). That on p. 318 Karstens says: "The shaft furnace, in which the hearth is partly in the furnace and partly in front of it, the slag runs of its own accord over the fore-hearth and the metal and matte is dipped out into a tap basin; sometimes, however, these tap basins are dispensed with; that is to say, out of the basin or sump in front of the furnace." And again, on p. 320, he says the slag enters either through that lower hole into the fore-hearth, or we use a second open-eye above the fore-hearth; the only object of the upper eye being to withdraw the slag. (The inference being that the lower eye is used to withdraw metal). That in smelting operations where little or no slag is produced the upper eye is dispensed with, as in case of litharge or oxide of lead (pp. 41 and 42). So he describes a sump furnace on p. 320 as a sump furnace with open breast, in which the slag had no special opening. Such a furnace is used to-day (p. 42).

A sump furnace is a shaft furnace of which the hearth is partly inside and partly in front. Karsten says: "The slag runs

of itself over the fore-hearth" — over it, not in it. It is *ueber* — over. The lead-well being full, it would run over it (p. 50).

Then, in Vol. V., he gives certain dimensions of the furnace, and gives a section of it in table 41, No. 860 (p. 42). He does not give the depth of the lead-well, but by use of the compass we get it pretty accurately (p. 43).

That he saw this drawing in Karsten; took it and constructed a furnace from it, with the view of producing a certain result (p. 47).

He says further: "The arrangement of this furnace is shown by figures 858, 859 and 860;" and goes on to give certain demensions (p. 48). This furnace represented by figure 860 is a furnace with a fore-sump or fore-hearth divided by a brasque partition. The figure shows the metal was tapped from the outside fore-hearth, into which it was drawn automatically from the inside. Karsten says it may be tapped or dipped (p. 49). On page 318, he says: "Sometimes these furnaces have no tap basin, and then the metal is dipped with a ladle out of the fore-hearth — that is to say, out of the sump (we might translate) basin;" that is, out of the basin in front of the furnace (p. 50). That from that description alone he could construct a furnace (p. 50). Fore-hearth is rather indefinite with the Germans, but Karsten calls the projection in front of the breast the fore-hearth (p. 50).

Karsten does not say the fore-hearth is used for the purpose of drawing off clean metal, but it is shown by all the drawings and from what he says, that the metal is separated from the slag by means of coming in through a hole, rising up in the basin, and after getting there is tapped out into another basin (p. 52), or dipped out clean (p. 51).

He says this furnace has the arrangement of the high furnace for concentrates (p. 48). The description is of a sump furnace, and any one would recognize it as such from the description. On page 320, he says the slag runs off constantly; he speaks of a sump furnace with a covered eye, in which the brasque under the front wall divides the same into two communicating vessels, the slag runs

off through the constantly open eye between the front wall and the brasque. People use this kind of arrangement when they wish to dip the metal off clean. It shows a 3-inch open eye — with which, however, no furnace will run — (p. 51); and witness said that he had constructed a furnace from and according to the description (Vol. III., p. 320 and Vol. V., p. 166) and diagram figure 860 in Karsten (Record, p. 38), and run it sixty to ninety days, and until defendants' works [and said furnace] were destroyed by fire, at Leadville, in 1881 (Record, p. 38 and bottom p. 40). Witness exhibited a model of such a furnace, to show its appearance and how it worked — model made by workman from scale, etc. (Record, page 43 and top p. 52). This represents a furnace of six to eight tons capacity, whereas the furnaces in use in Colorado to-day are about thirty tons.

Witness says, when the furnace started some lead came down, and after getting it full of lead commenced charging the ore, and the furnace went to smelting, and we dipped the lead out of the basin — charged it just as did other furnaces — drew the slag off in different places; made furnace so we could draw it off from side or wherever we wanted to; ran it off in a channel; that got as clean metal as any furnace; and again ran it over the lead-well, where it formed a thin crust, which we threw off and got the lead out. We got as clean metal as with the Keyes & Arents attachment. It effected the automatic separation of the metel from the slag as completely as any furnace that was ever built in the world. So long as the metal remains above the closed (covered) eye, it is impossible for any lighter material to get into the outside basin. (Record page 39). That he put the Keyes & Arents attachment also on this furnace, and worked it with both attachments at same time (record bottom page 40), and the lead rose and sank in both alike (record page 41). The witness says any one familiar with furnaces and their construction will readily understand what the furnace is from the description.

W. H. James testified that he was an educated metallurgist; was a member of Grant Smelting Company since 1880; his business was general supervision over the works. He saw the furnace planned and built by Mr. Grant (Record, page 79). It was the

furnace of which this (defendants' model) is a model. It ran about three months, and until smelter burned. There was no difference in the action of the Karsten and Keyes & Arents lead-well. (Record, page 80).

The writer hereof was not present at the trial of this cause, was ignorant of the fact that two experimental furnaces were built by defendants, and, from the fact that the evidence does not disclose means of identifying the two sets of models, has misquoted the evidence in relation to said furnaces, and the error was not discovered until the argument was printed. J. B. Grant testified that he built a small furnace, of seven or eight tons capacity, from and according to the description and diagram, figures 858 to 860, Karsten (Record, p. 38), which furnace was run about a week (p. 52, bottom). This is the furnace whose working is described by witness on page 39 of transcript (Argument, p. 18). This is the furnace, also, to which the testimony of Messrs. James, Bieger, and Smith referred, quoted by me on pages 18 and 19.

Mr. Grant built another furnace — a large one, such as they use now — and to this was attached the inclined or Keyes & Arents tap, and also the right-angle tap, such as Karsten describes and illustrates, and the American and Pueblo smelters use. This is the furnace which was run sixty to ninety days, and until the works burned, and in which the operation and action of the two lead-wells were exactly the same (Record, middle p. 40 to middle p. 41). Mr. James's testimony in chief, except the last three interrogatories, refers to the Karsten furnace, and they to the large model furnace (pp. 79 and 80). The main distinction is that the Karsten furnace had but one lead-well and ran about a week, and the large furnace had two lead-wells and ran sixty to ninety days.

All through my argument the distinction as to these furnaces is not made, and, but for this correction, might be misleading. It can make no material difference, however, as the principle is the same in both, and they acted alike. So far as the lead-well and its action are concerned, there is no difference whatever. Models of both furnaces will be shown the court.

W. M. G.

If this be true, then there can be nothing new and novel in plaintiffs' alleged invention, and their patent is, for that reason, void.

The defence to the case thus made is wholly by expert testimony. Plaintiff Albert Arents testified that in his opinion a furnace constructed literally according to the description and diagram in in Karsten would not work at all (Record, page 99), nor in any event produce clean lead and metal (Record, pages 101, 102, 104, and 113). But never saw a furnace like it (Record, page 107); that at last trial he very likely said 860 was a very old furnace (page 108). Don't believe Mr. Grant constructed and run the furnace of which his model is a correct representation (Record, page 112).

Frank Faure testified that in his opinion a furnace built according to figure 860 and description in Karstens would not work (Record, pages 116 and 119), but that at former trial he said such a furnace had been used to smelt iron (Record, page 118); and he don't believe Mr. Grant, if he says he built a furnace according to this model and it worked (page 119, bottom, and top 120).

Anton Eilers testified that in his opinion such a furnace would not work and produce clean metal (Record, pages 120, 123, and 126); that he never built or saw such a furnace (page 126).

Prof. Hahn testified that such a furnace, in his opinion, would not work and produce clean metal in the lead basin (Record, pages 129 and 130).

A. Hartwig testified that such a furnace in his opinion would not produce the same result and accomplish same purpose as Keyes & Arents' furnace (Record, page 132).

Milton Morse testified that such a furnace would not, in his opinion, produce the same practical result as to clean lead and metal as the Keyes & Arents' furnace (Record, pages 135 and 137); but he never built or saw such a furnace (page 137).

Plaintiff W. S Keyes testified that in his opinion a furnace built according to the description and figure 860 Karstens would not produce clean lead in the fore-hearth (Record, pages 139 and 142); but if the slag hole was put to one side, the Karstens would be a

modified Keyes & Arents' furnace (pages 144 and 145); that the only thing absolutely new about their device is the slant (to the tube) (page 146).

Here, then, is the testimony of four witnesses, as to what they did and saw done, and that of another, that he had seen the furnace work; and on the other hand, that of seven witnesses, that in their opinion the thing done could not be accomplished.

What is the rule of law applicable to this evidence? It is this: The positive statement of a witness as to what he has seen or knows outweighs any amount of negative testimony — Fourth edition, Curtis on law of patents, 649, section 491.

Manton vs. *Manton*, Dav. Pat. Cas. 250.

In *Union Sugar Refinery* vs. *Matthiessen*, 2 Fish, 600, it is said the affirmative statement of a witness as to what he saw and heard is entitled to more credit than the negative statement of another witness that he did not see or hear it.

There is nothing more unsatisfactory or more uncertain than expert testimony, and especially when it is of a scientific nature but when scientific men undertake to convince the average mind that what it sees and knows is not and cannot be, it looses its force and becomes rediculous.

One set of witnesses say this thing cannot be done because it is contrary to the science of metallurgy; the other set say, not only is it not contrary to any such principle, but they have done it, and successfully. Nearly all of those seven men are not only educated metallurgists, but they are practical smelters; yet they had never seen a furnace constructed upon this principle, nor did they go to the trouble and very nominal expense of constructing such a furnace, and putting their scientific knowledge to the test of practical experience, although there had been one trial of this case; the construction and operation of said furnace proven; and they must have known that the issue at the trial depended largely upon the result that this experiment produced. It is hard to believe that they would be so negligent of their interests.

Under these circumstances, can there be any earthly doubt in the minds of unprejudiced men as to the fact at issue? Theory can never outweigh fact, and the practical test to which defendants' witnesses applied Karsten's furnace, must be conclusively satisfactory that plaintiffs' witnesses were mistaken. No court in the exercise of its sound discretion could have refused to set aside a verdict against defendants' on that evidence.

Besides this practical experiment — always most satisfactory — the defendants' theory of the case on principle is sustained by the evidence of such men as Robert Biewend, plaintiffs' own witness (Record, p. 81), Dr. John Percy (p. 82), H. Bauerman (p. 87), John M. Ordway (p. 91), Robert H. Richards (p. 94); all of whom are scientific men, some professors, and some authors of scientific treatise, and they all testify that plaintiffs' device is the same as that described by Karsten, and acts upon the same principle and will produce the same result. In the trial of an issue of fact, the evidence of these men is entitled to as much credibility as that of plaintiffs' witnesses, and the result would be a guess by the jury; but the practical test furnished by the other five of defendants' witnesses and the one of plaintiffs' is uncontradicted, and their veracity not doubted; and besides, the court can see for itself that the devices are the same. Hence, we insist that the evidence, with all the inferences that can be justifiably drawn from it, will not support any other verdict than that ordered by the court, for defendants.

IV.

Plaintiffs' witnesses have given reasons for their opinions, and have attacked the model of Karstens' furnace presented by defendants, and that requires that we look more closely into the evidence.

J. B. Grant testified that he understood drafting and the building of furnaces from drawings or models (p. 38); that he had built twenty to twenty two furnaces (p. 34); that taking the diagram figure 860 and description in Karstens' (Vol. III., p. 318 to 320, and Vol. V., p. 166), he could construct a furnace that worked on the same principle, and produced the same result, and in the same

way, as the Keyes & Arents attachment; that he did construct such a furnace (p. 38), and worked it (p. 39); that he made, or had made, a model of such a furnace and it was used to illustrate its workings to the court and jury, and will be shown this court for inspection and comparison; (p. 39, 41 and 52). Defendants' other four witnesses, who saw the furnace work, testified that it was built according to the model.

Plaintiff Arents also produced a model, which he claimed was a perfect representation of the Karsten furnace so far as it was in controversy in this case (p. 97), which he claimed was drawn to a scale, and was explained to the court and jury (p. 97). It will no doubt be exhibited to this court. Witness says this furnace is tapped in the same way as those at Eureka were before his invention. That the tap hearth and tap basin are the same, and the office of the fore-hearth is to serve as an outside vessel from which it is easy to tap the metal from the bottom — a kind of basin to receive all molten masses before they were discharged from the furnace. The court will observe from the model that the part of the furnace in front between the lead-well and crucible is called the breast. Witness says if this breast were left open the blast would rush out and you could not smelt with it, hence, the lower portion of the front wall is sunken down between the two compartments into the hearth. So the wall sinks down into the molten masses, the lead column and slag stand on either side of it; the connecting-hole (or eye, as it is called), being larger or smaller. This portion is of brasque (which is a mixture of charcoal and fire-clay), crumbles easy, and does not last over about twelve hours. [Mr. Grant testifies that it is temporary in one sense, but will last several days or weeks (p. 52 and 53). Karstens made it temporary, that it (the furnace) might be cleaned out (p. 98).] With this basin attached to the front, the front has to be thin, and is hence destructible, but if it was at the side, through solid masonry; it would be substantial.

Our lead-well is higher; so no matter how much slag collects, it will not overflow, and nothing else can get in; while in Katsten's it is low. Karsten's furnace won't work because its proportions are not right — too small or too low.

The intention of this furnace was not to have clean lead pass through this hidden eye, but to prevent the blast from passing out

of this open breast. The hidden eye was, prior to Karsten's, placed as a tap where Karsten's open eye now is, the bottom of the furnace being then higher up. In this shape, the furnaces blew frequently, hence the bottom was made deeper, and the eye or tap changed to a hidden eye, through which no blast escaped, but all the molten products, still passed together, being in the same state as inside — the same as in the fore-hearth with open breast. This model (defendants') is very much like 860 of Karsten's. It lacks the heavy masonry, and the tap hearth, and tap canal, without which it is no furnace, so far as the withdrawal of clean metal is concerned.

If the open eye is closed, the lead and everything else will be forced out into the lead basin, because it is not high enough above the bottom of the furnace. If you heighten that proportionately, then it will be complete. Put the slag-eye to one side and you have a furnace like ours. In our furnace the lead ascends from the crucible upwards, and in Karsten's it runs on a grade directly through between what is called a temporary partition; the same as an open sump furnace (page 101). The change of the slag-tap from the center of the front wall is a material change in the art of smelting, and is never done. Karsten describes the upper part or shaft of 860, but not the lower. Mr. Grant and the other witnesses say so, but are mistaken. Figure 860 was used at Clausthal, but without the open-eye to revivify litharge only; but this furnace where matte is smelted has not that arrangement, and Karsten has not described 860 (p. 103; see p. 104 as to Karsten's description, Vol. III, p. 320). The slag-tap can not be put at any other point than right in front, for it would be so long the slag would not get through. If an open-eye is used, matte and speiss would get in the fore-hearth. The lead would stand equally high on either side of the brasque partition. Only a thin layer of slag is formed, and the blast will blow out and make only slag (page 105).

The plate 860 appears with a hidden-eye, and above the fore-hearth is a slag-eye — an opening, I don't know what it is for. This is a sump furnace, and has no tapping to it (page 106). The

breast simply descends a little lower down than in a furnace with an open breast. There is no line of demarkation between a hidden-eye and open breast; the latter has a larger opening, that's all; 860 is not his (witness') idea of an open-eye. According to the scale in Karsten's, this lower-eye is three to three and one-half inches. He don't know the size of Keyes and Arent's tube or channel, but the length makes the difference. If it is short it might be an eye, and if long, a channel; theirs (plffs.) is a channel. There is a wide difference, and it depends on the thickness of the substance through which the opening passes (page 107). He never saw a furnace like 860 used, and don't know whether it was ever used or not. It has been without that (upper) eye. On former trial he may have said that it was an old furnace and had gone out of use. He thinks that furnace can't work because it has an open-eye — upper — (page 108). If the tuyere is raised, it will be too high and the furnace chill. You can shut the slag-eye, but then it is a tap and not an open-eye (page 110).

He don't believe Mr. Grant constructed and ran the furnace of which his model is a correct representation, for in his opinion it would not work (page 112). If the slag-eye is open the blast will blow out, and if closed the slag will press out underneath — the dimensions are so low. That was the state of the art; now it is different. Put the tuyere higher; the hearth higher in same proportion, say ten inches, put the slag-eye somewhere else, make that wall (breast) thicker, then it will work successfully (page 113). "We claim that any ordinary furnace with a basin attached, receiving slag from neither above or below, and only clean metal, is ours" (page 114).

The model of defendants' is conceded to be substantially correct, and it will be before the court, and it can see for itself how the metal was tapped off or dipped out, and it is apparent that it was not done as stated by the witness. The tap canal spoken of is no part of the furnace, nor is the outside or third basin.

The witness also admits he never saw a furnace like 860. So that whatever else he may say is conclusively answered and overthrown by the actual test made by defendants with the Karsten furnace.

He don't know that the Karsten furnace was ever used, and he says it is not described; then by what authority does he say that the office of the fore-hearth was to receive all the molten masses; that the breast was extended down only to keep the blast from blowing out. The trial made showed this is not true.

There is nothing else stated by the witness which alters the principle of operation of the two furnaces. His opinion can not alter an established fact. If the brasque partition was thin and destructable it could be made substantial with different material. If the slag-eye was too large, it could be made smaller, or closed; if the proportions of the furnace were too small they could be increased; if the lead-well was too low it could be raised, and so with the slag-eye and tuyeres; if the hidden-eye is too large, make it smaller, but observe it is no larger in Karsten's than in plaintiffs', and not near so large as the Pueblo Company use. No principle of the furnace is altered by these changes. The business sense of the smelter will suggest these things as the working of his furnace may demand. It is not true that a change of the slag-hole from the front is a material one in the art of smelting. About all the witnesses said that it was put wherever most convenient for the smelter, and J. B. Grant said it was at the back of the furnaces in Frieburg, in 1876 (pages 37 and 58), where he worked at furnaces so built. Witness claimed the difference between his furnace and Karsten's to be, that his tube slants upwards from the bottom of the furnace, and Karsten's goes straight out on the same level, and claims this to be a material change; but the absurdity of it is so apparent that its bare statement answers it; yet he admits that if the slag-hole in Karsten's is placed in some other position than directly over the lead-well, it is their furnace.

Plaintiff Keyes also admits that the slant of the tube is the only new thing about their device (page 146). This is apparent, and how any question of principle or inventive skill is involved is beyond my understanding. This, too, is in accordance with the claim in their patent. They undertook to patent a device for getting clean metal out of a furnace, and they did it by placing the lead-well, according to patent, at the side of the furnace, and according to their evidence, at some other point than under the

slag-hole. This, and the form of the lead-well, is a mere matter of convenience. Place their lead-well under the slag-hole and the slag will run in, unless guided over or around by a channel.

No mention was made of the slag, but they now claim the greatest difficulty is the slag and metal will come out together in the lead-well; but the experiment made proves this to be a mistake, and the evidence shows the slag can be forced into their lead-well as easily as in the Karsten; so can the matte and speiss, but they have nothing to do with it; are due to other causes, and prevented by other means (Record, p. 44, evidence J. B. Grant, and p. 75, Geist).

Mr. Grant admits that the furnace with an open three-inch slag-eye will not work, and plaintiffs say if you close this or make it smaller you might as well change any other part of the furnace. Removal of the slag is not in dispute, neither is the construction of a furnace. If the furnace would not work with a three-inch eye, any man of sense would make it smaller or close it. However that may be, the furnace must be made to work before any metal can be made, and when it is made, then the Karsten device removes it in the same way, on the same principle, and just as clean as plaintiffs; that done, plaintiffs' patent falls, for that is the thing sought to be patented; it is not new.

Plaintiffs' witness, Frank Faure (page 115), adds nothing to the testimony of Plaintiff Arents as to the models, and his cross-examination shows that his evidence is not entitled to but little, if any, consideration.

Anton Eilers says the model is accurate, except it lacks the outside basin and tap canal or channel (page 120). He adds nothing to Arents' testimony, and on page 125 admits that on former trial he stated that if Karsten's was deeper it was plaintiffs' device, and that the plainest difference between Karsten's, and Keyes & Arents' devices was that Keyes' had a tap for slag, not in Karsten's; Now he says the plainest difference is the height (page 125). The principle of the two furnaces is the same (page 128).

The court will observe that on the former trial Mr. Eilers could find no difference between plaintiffs' and Karsten's furnaces; so he said the difference was Karsten's showed no slag-tap. He now says the principle of operation is the same, but the difference is in the height, or proportions, as I suppose.

Now, what does this amount to? Simply that the Karsten's furnace has not proper size and proportions to smelt the ores we use to-day, but if that is fixed the furnace will produce clean metal same as plaintiffs. That is what we contend, and it is all we need to defeat plaintiffs' patent.

In their patent they claim nothing in relation to the construction of a furnace or removal of the slag.

Prof. Hahn (page 128) adds nothing to Arents' evidence, and on page 131 says plaintiffs' furnace is like Karsten's except in the latter there is not sufficient lead in the crucible, and slag-eye is too low.

A. Hartwig (p. 131) adds nothing to Arents' evidence. He says the plaintiffs' lead-well is sometimes tapped to get cool lead and Karsten's was to get clean lead (p. 134). How does he know that? he says the furnace is not described, and he never saw one; that's his opinion, which, in the light of defendants' experiment, is worthless.

Prof. M. Morse (p. 134) adds nothing to Arents' evidence, but on page 138 he says it makes no difference whether the connection between the crucible and lead-well (the tube or channel or hidden eye) runs straight out on a level or on a slant, as in plaintiffs' furnace. Mark you, Plaintiff Keyes says the only thing new about his invention is the *slant*. Now, if there is no difference, where is the inventive skill exercised — of course, there is no difference — and there is nothing new in the invention. Mr. Geist says his company uses the straight connecting channel altogether, and Mr. Smith says the American smelter does.

Plaintiff W. S. Keyes (p. 138) adds nothing to Mr. Arents' evidence as to models, etc., and on page 143 he says a straight channel

from the bottom of the furnace to an outside lead-well, where lead rises to the same level outside as inside, is theirs. Karsten's is not that, for his lead-well is a receptacle for all molten masses, where they have a quiet place, and the metal settles by gravity to the bottom; and on page 144, on former trial, he said if Karsten's slag-eye was put to one side, his would be a modified Keyes & Arents furnace; and on page 145, he said, then and now the principle of communicating vessels is the same in both; the metal ran through the hidden-eye and rose to same height in outside lead-well as in inside crucible upon the principle of hydrostatic pressure; that when the lower-eye is covered with metal the slag ran through the upper-eye. Whether slag ran through the lower-eye depended upon whether they first got in metal enough to cover it — upon the choice of the smelter. If the brasque partition was made of imperishable material, and slag-eye set to one side, he would have a modified Keyes & Arents furnace. A Karsten furnace with a tap attached to convey the slag away would not act badly, and so long as lower-eye is kept open, would act like theirs; and on page 146, if there is anything new — any part or portion absolutely new — it is the slant (to tube from lead-well to crucible).

J. B. Grant testified further, that Mr. Karsten does not say in so many words that the metal passed under that partition and rose automatically, but the fact that he says it was dipped out of the sump or basin in front of the furnace shows that such was the fact, and his description shows that the principle was not unknown to him (p. 56). The object of the fore-hearth was to collect metal — withdraw it from the furnace — that in his opinion the Germans ran the slag over the metal because they thought the lead, being exposed, would oxidise a good deal, and besides, there were always shots of lead in the slag that dropped in as the slag passed over. That on pages 186–7, Vol. IV., Karsten speaks of a furnace used to smelt iron only and not lead. Lead smelting was not carried on to a great extent until 1869 or 1870 — not carried on in blast furnaces outside of Germany, which accounts for absence of other furnaces than old tap-hearth and basin, until about that time (p. 57); that we are not indebted to Keyes & Arents, but to the Scotch fore-hearth for keeping lead on the bottom of the furnace (p. 60).

Mr. Geist, manager of the Colorado smelters, at Pueblo, testified that they ran eleven furnaces, withdrew the metal in two ways — some they tapped the metal and ladled it, or tapped it out into a a lower basin and ladled it from there (page 74).

They run two furnaces with Keyes & Arents' attachment, only they have no slant; they run a channel straight from the bottom of the furnace (page 75).

It makes no difference, in either case, whether the furnace has the side method of drawing off, or the other (front) (page 76). Their slag spout is on the other (opposite) side (page 75). Their connecting canal is not less than 6x9 inches, (page 76).

By dipping out, too much lead, slag, etc., can be forced through channel (as in plaintiffs' device, model referred to) into the lead-well (page 77).

Mr. Smith testified that all contents of furnace can be forced out through plaintiffs' lead-well (page 70); that the American smelter, in Utah, used a straight connecting tube in 1878, and set lead-well to one side of slag-spout, but in the fore-hearth; and Plaintiff Arents managed a smelter within 200 feet of it, and never demanded any license (page 76).

IV a.

We insist that from the testimony of Mr. Keyes alone, any verdict against defendants would have and should have been set aside by the court, and hence the court was justified from it in ordering the verdict for defendants. He says the hydrostatic principle of communicating vessels is the same; that when the hidden eye is covered with metal the slag will run through the upper eye, the metal rise to the same height out as inside and if the slag is guided over the lead-well, or the tap set to one side, the furnace will not act badly and will be a modified Keyes & Arents furnace.

The court can see from what he says that the only difference is in the slanting tube, the advantages in favor of which have not been shown. In the light of this evidence, what is there to discuss? No principle is involved; the only question is one of convenience, and while it may be more convenient, the evidence

shows that no more men are required, or time or money spent, in using the Karsten's than Keyes & Arents' furnace (see evidence J. B. Grant, pages 43 and 44, Geist, page 75).

The court will observe that a great deal has been said about the constuction of the Karsten's furnace and the proportion of its parts, and on pages 132 and 135 plaintiffs' attorneys asked the witnesses whether a Karsten's *furnace* could be constructed from his diagram and description by a practical smelter who had not not seen a Keyes & Arents' lead-well; and of course, as expected, they said no. This amounts to nothing, and I can't understand why it was done. The question is not as to the construction of a furnace, or a patent upon a furnace, but a specific connection and for a specific object. I might, with equal propriety, ask if any practical mechanic who had never seen a furnace at all could take Keyes & Arents' specifications and diagram and construct a furnance with their lead-well attached that would produce clean metal. He could not, for all the parts of a furnace are not there. It's all nonsense. Smelting is as old as the book of Job, where it is said, "Surely, there is a vein of silver and a place for gold where they fine it. Iron is taken out of the earth, and brass is molten from the stone." There is no patent on a common furnace; anybody can build a furnace, and if the proportions don't suit they can be changed until they do — but when you have a furnace that will work, how will the clean metal be gotten out? It must be apparent that whether by the device attached to the Karsten furnace or plaintiffs' it is the same, and plaintiffs' is hence not new; and that the Karsten device can be attached and worked has been shown, regardless of the fact that experts have sworn that in their opinion it could not be done.

Karsten describes a sump furnace. It is a sump furnace to which plaintiffs' device is intended to be attached. It is a sump furnace defendants use. Can any man say that it is not as easy to build, or to comprehend the building of one with a partition, from Karsten's description, as with a lead-well, from plaintiffs' description; or that they will not act alike when built?

Plaintiffs' attorney even questioned defendants' motives for building the furnace, and asked J. B. Grant if he did not do it after this suit was brought, and why he did it. He answered: "Yes, sir; and I can tell you what I did it for — simply to prevent your experts from misleading the court and jury in regard to the facts in this case. I never put it up to work for money" (p. 47); and, again, he said he built it to see if it would work satisfactorily, as Prof. Percey said it would, and with a view to using as testimony in this case (p. 61).

This furnace was built in 1881 — the case first tried in June, 1882, and second time in November, 1882 — yet plaintiffs and their witnesses made, or at least made known, no effort to see whether or not the Karsten attachment would work or act as they thought it would. They knew it had been tried and did not prove their theory; they knew the Pueblo company and American smelter used substantially the same thing, and this may account for so many of them changing their views with reference to the furnace and attachment, on the last trial. They virtually abandon the lead-well and attacked the furnace. At first the *principle was the same*; but Karsten's would not produce clean metal, because the slag-eye was over the lead-well; but on the next occasion, without any additional information or means of knowledge, nearly all of them discovered that the slag-eye was too large, and the brasque partition was not permanent, and would blow out if slag-eye was not closed; and that slag would run into the lead-well promiscuously with the metal, and the metal couldn't be dipped out clean, and couldn't be tapped, because the crucible was too shallow, and the proportions of the whole furnance were too low to work — wonderful change, this, in four or five months, with no other or further information than knowledge of the fact that their witness, Biewend, had seen such a furnace, and that such a furnace had been worked successfully by defendants. Why didn't they know these things before? Perhaps it was not at first thought necessary to plaintiffs' recovery. It is clearly evident that all these witnesses and plaintiffs regard the invention to consist in removing the lead-well to the side of the furnace, and from under the slag-tap except Plaintiff Keyes, who sticks to the slant in the tube or

channel as the invention — that, I believe, being his discovery or suggestion in the device. In either view they consider it, there is nothing new in view of the patent law — removing the lead-well from under the slag-spout, or the slag-spout from over the lead-well is a convenience only, and not a patentable invention. As to the proportions of the Karsten furnace, they could all be changed, if need be, and any man of sense would do it until it worked, and then get his metal out of the lead-well by tapping or dipping, as Karsten says and as plaintiffs' do; and the principle is the same still.

V.

Neither does it make any difference whether this furnace was ever used. Karsten described it, and it has been proven to produce the same result in the same way, and that is sufficient.

Parker vs. *Fergusen*, 1 Blf., 407.
Hildreth vs. *Heath*, Cranch Pat. Dec. 96.,
Coffin vs. *Ogdon*, 7 Blf., 61.
Johnson vs. *Root*, 1 Fish, 351.

It is not a case of prior use, but of prior description. But plaintiffs' witness, Prof. Biewend, on cross-examination, testified that he had seen furnace 860, described by Karsten, at work (p. 81), and if it acted as Mr. Arents said it would, why did they not prove it by him?

Nor is it material that defendants paid plaintiffs royalty at one time on the patent.

Evans vs. *Eaton*, 3 Wheaton, 454.
Evants vs. *Hettick*, 7 " 453.

The explanation for such payment is ample (Record, p. 44) to relieve defendants of any appearance of assenting to the validity of the patent.

VI.

The testimony of H. Bauerman alone is sufficient to sustain the issue for defendants. When shown a copy of Keyes & Arents' specification and diagram, and asked as to their novelty, he said that he did not consider the invention novel.

First. That the physical principle involved — the hydrostatic principle of communicating vessels — is not new.

Second. That the details are not new — the extension on one side with basin and tube is substantially similar to an exterior fore-hearth in continuous communication with the working hearth or crucible, which latter arrangement has been described as in use long before the date of the specifications.

Third. That the method of keeping the hearth bottom covered with molten metal — which is the practical result of the arrangement — is an essential detail of the fore-hearth method of smelting which has been practiced in England and America for years previous to the date of the specification.

Fourth. The practice of removing the metal from the fore-hearth continuously — which is another result of the arrangement — is not new; it is to be found in the ore hearth process and in the process followed at Blieburg in Corinthia.

Fifth. That the method of removing the metal from the fore-hearth by ladling was practiced in France by iron founders, according to published accounts, in 1765. (And when asked if he knew of the same principle being in use in America prior to 1871, he answered:) "The only lead-furnace which I know to have been in use in America previous to the date of the specification of Keyes & Arents' patent is the American ore hearth, which I saw in action in Missouri in the spring of 1871, at *Mine La Motte*" (page 88).

This is repeated on cross examination; and he adds that the Leadville ores were then unknown.

We call attention to this evidence for two reasons:

First. Plaintiffs and all their witnesses insist that Karsten's furnace is impracticable, and that the principle of their invention is impossible except when used as they describe, while this evidence shows that they have been used for iron and other ores since 1765, in France, and since then in Corinthia, England, and America.

Second. That their invention was used in Missouri in the spring of 1871, where witness saw it at Mine La Motte. This evidence threw the burden on plaintiffs, and if it was not true why did they not show it, as this evidence was seen and known by them five or six months before the last trial? Would they not have shown it untrue if such had been the fact? This witness is not impeached, his evidence is concise and to the point; and not only proves conclusively defendants' case, but removes all doubt as to the evidence of defendants' other witnesses, if there were any, which plaintiffs have attempted by expert evidence alone to overthrow.

The evidence of one competent witness is sufficient.

Coffin vs. *Ogden*, 18 Wallace, 120-124.

VII.

The plaintiffs' patent covers a lead-well and attachment to an ordinary blast furnace, and if their patent is valid, defendants have infringed it. The question is:

First. Was a lead-well described in Karsten's, published in 1831-2, and used at Mine La Motte, Missouri, in the spring of 1871, prior to their invention, which produced or could be made to produce clean metal in it upon the same principle, and in the same way? The evidence that such a device was used at Mine La Motte is not disputed.

Second. Was the same thing used at Bliberg, in Corinthia, long prior to 1871? It is not denied

Third. Was the same thing used in France and elsewhere in iron furnaces since 1765? It is not denied, and their own witness, Fahr, admits it was used on iron furnaces.

It is conclusively proven that a furnace built with the attachment according to the description and diagram in Karsten does work upon the same principle and produce the same result. The evidence attacking this defense is wholly expert, and nearly or quite all of it directed not against the lead-well, but the furnace to which

it is attached, and we shall only notice now such as is directed to the lead-well. It is said that the lead-well shown by Karsten was intended to receive all the molten contents of the furnace — a quiet place where the metal can settle at its ease and be drawn off; but not a word from Karsten is quoted to prove such to be the fact; nor is it shown that such use was made of it in practice by their witness, who admits that he has seen it work. And while it may be true that Karsten does not say specifically what it is for, the fact that he says the metal may be dipped out or tapped off shows conclusively what it was intended for. Suppose he said nothing about its use; it is shown and described, and has been proven to produce that result, and that is sufficient to defeat a patent for any use to which it can be put.

Richardson vs. *Lockwood*, 6 Fish, 454.

VII a.

And again, it is said the partition in the crucible is made of brasque, which is not substantial, and if Karsten had intended the outside basin as a lead-well, he would have made it permanent. It is sufficient answer to this to say that the quality of the materials of which the furnace is made does not affect the principle of its operation or the result it will produce. The more probable reason for making it of brasque is given by Mr. Grant (Record, page 53); that in Karsten's time they did not run furnaces constantly — only smelted a few days at a time — and he made it of brasque so the furnace could be more easily cleaned. But it can be made of fire-brick and made as permanent as any part of the furnace. That is substantially all that plaintiffs have done, but it does not involve inventive genius and is not patentable.

Hotchkiss vs. *Greenwood*, 11 Howard 248.
Hicks vs. *Kelsey*, 18 Wallace 670.

VII b.

And it is said that this partition was extended down into the open breast, not to make a lead-well, but to keep the blast from blowing out only; and if it had been intended to make a lead-well

the opening below would not have been so large. The evidence shows that the opening is not over three to three and one-half inches (Record, page 54); and that it is fully that large in plaintiffs' tube (Record, page 81), and the Colorado Smelter Company use an opening six by nine inches (page 76), so that theory is theory only, and based upon a false assumption.

VII c.

And it is said the lead-well is set too low to be successfully worked; that a sufficient lead bath can not be kept on the bottom of the crucible. The evidence shows that the lead bath was in use, long before their invention, in other furnaces — especially in what is called the Scotch ore hearth; but whether that were true or not, it does not affect the principle. If too low it could be raised, and and the action of the lead-well — so far as it is concerned — would be the same.

And finally, that speiss, and matte, and slag would get into the Karsten lead-well and interfere with its work, and prevent getting clean lead; but the evidence shows that speiss and matte are ~~due to mistake or ignorance of the smelter, and should not be made, and if made are~~ just as liable to get into plainitiffs' as the Karsten lead-well, and that they and the slag can be forced into any lead-well, or kept out. All this is conclusively answered by the experiment made by Mr. Grant, where none of the difficulties predicted were encountered.

VII. d.

These experts also thought that if the Karsten lead-well did work it would be very expensive to operate — Mr. Arents thought the expense would be about $300 extra per month for each furnace; but that was on the assumption that the lead-well could not be raised if too low; but be that as it may, the evidence of Mr. Geist (page 75) and Mr. Grant (page 43) both show that no more skilled labor is required to use it, nor does it take any more men or cost more money; and as Mr. Geist had tried it in one form and Mr. Grant in both, their evidence ought to be conclusive.

All other objections relate exclusively to the furnace, and if it were material to discuss it, the experiment and evidence of Mr. Grant answers them all; but they are out of place here.

The question is resolved finally into one of convenience. All plaintiffs' experts knew plaintiffs' was most convenient; and most of defendants' witnesses admit that to be true with certain kinds of ores, but Mr. Geist did not so consider it for any ores.

Suppose it is more convenient. It is at most a mere carrying forward or a more extended application of original thought — a change in form, proportions, or degree only — doing the same thing in the same way, by substantially the same means, and with the same result; perhaps to put it strongly for them — better results. Such is not the subject of a patent.

Smith vs. *Nichols*, 21 Wal., 112;
Roberts vs. *Ryer*, 91 U. S., 150.

VIII.

Plaintiffs' own witness, Fahr, and defendants' Mr. Bauerman, show this device was before used on iron furnaces. The mere application of an old process to a new purpose, with no change in manner or substantially distinct result, is not patentable. There is not invention or discovery.

Piper vs. *Moon*, 10 Blatchford, 264;
Hause vs. *Abbott*, 2 Stoey, 190;
Meyer vs. *Pritchard*, 12 Blatchford, 101;
Bray vs. *Hartshorn*, 1 Clifford, 538;
Brown vs. *Piper*, 91 U. S., 37;
Miller et al. vs. *Foree et al.*, Sup. Ct., Rep. Vol. VI., No. 6, p. 204;
R. R. Co. vs. *Locomotive Truck Co.*, 110 U. S., 490;

IX.

Plaintiffs' invention consists in setting the lead-well to one side of the furnace (and from under the slag-spout; though as to this their patent is silent). That is the method by which clean metal

was to be obtained by their device; and to bolster up that claim, they undertook to show that it was a material fact in the art of furnace building, that the slag-spout should be in front. But Mr. Grant shows that when he was in Frieberg, in 1876, the slag-spout was in the back of the furnaces, and so Mr. Geist testified his were built. This, it is true, was since plaintiffs' invention, but not on furnaces with their device, and in Germany their device was not used at all — not discussed in the lectures — and, presumably, not known; and all defendants' witnesses swear that it is customary to put the slag-spout at any point most convenient for the smelter. Besides, it is shown that the lead-well may be set under the slag-spout and the slag kept out of the metal by a removable gutter over or a channel around the well, or to one side of the lead-well in the fore-hearth.

It is too absurd to believe for a moment that any court will hold such a change to be one of principle, or to involve the exercise of inventive genius. It required nothing more than the exercise of such business talent as any man of sense, any head workman, any artesian, is expected and ought to use in the performance of his duty. To hold such to be an invention or discovery would be to place an embargo on the business talent of every man in the land. Every change from an established custom, every modification of a tool, implement, or machine, however unimportant, so that it facilitated the transaction of business, or increased the product of a machine, would be the subject of an invention. In this way the patent law would be made an oppressive monopoly, and retard instead of advance the material prosperity of our country.

Furnaces are old; the fore-hearth or lead-well is old; and applying it to a lead furnace or setting it at some other point than under the slag-spout, and raising it high enough to be efficient on large furnaces, and for long campaigns, would occur to any practical man, and is not patentable.

Vinton vs. *Hamilton*, 104 U. S., 485.
Thompson, et. al., vs. *Boisselier*, 114 U. S., 1.
Philips vs. *Detroit*, 111 U. S., 604.

It is not the object of the patent law to grant a monopoly for every trifling device that should suggest itself to every skilled mechanic or operator in the progress of his profession or the pursuit of his art.

Atlantic Works vs. *Brady*, 107 U. S., 192,
and cases cited in 114 U. S., p. 12.

X.

If the court should concur with the court below, that there was no question for the jury to decide, the instructions asked by the plaintiff are immaterial, but we will endeavor to show that in any event they are not correct or are immaterial.

The first instruction (Record, p. 146, top) is erroneous in its descriptions of the plaintiffs' patent, and winds up with this declaration: "That the jury be satisfied that the plaintiffs acquired their knowledge and obtained their inventions or mechanical device from reading and knowing said foreign publication, and not as a result of invention or discovery of their own minds."

This is not law; it does not aid the plaintiffs' case if they never saw Karsten's book. The law says that if the thing claimed by the patent has been described in a foreign publication, it is not patentable. Whether the plaintiff knew of the description or invented a thing like the one described, is not material under the act of congress.

XI.

Second instruction (page 147, top); that the particular portion of the so-called Karstens furnace called the fore-hearth, which is claimed by the defendant to be the same as plaintiffs' automatic tap, etc.

This instruction was erroneous, because it assumes as a fact that the defendants claimed that the fore-hearth in Karsten's furnace was the same as the plaintiffs' automatic tap.

The fore-hearth described in Karsten's drawing is for the same purpose as the basin referred to in the plaintiffs' patent — namely,

to receive the molten metal as it is forced into it by means of an opening connecting the sump or bottom of the furnace by hydrostatic pressure. The words automatic tap used in the instruction refers to the tap, or opening, or tube described as the patented thing. Keyes says in his evidence (page 146) that "the only thing new is the slant," meaning the direction of the tube or opening connecting the two vessels. The patent don't say so.

XII.

The third and fourth instructions (page 147) were intended to withdraw from the court its power to construe the meaning of the thing patented and the thing described; which became, when the two instruments were before the court, a question for the court. Their identity was to be determined by the court; not by the jury.

XIII.

The fifth instruction (page 148) is erroneous, as No. 2;— substituting the fore-hearth and furnace for the connection between the two vessels.

XIV.

The sixth instruction (page 148) asked the court to charge the jury that, what is a furnace of ordinary construction in 1871, the date of plaintiffs' patent, and the mode of tapping metal from such furnaces, and the character of the slag exit, are questions of importance, because it is to such a furnace that the plaintiffs claim to have applied their discovery and improvement.

This instruction is entirely of too general and indefinite nature to have been given by the court. To say that a certain form of furnace is a question of importance gives a jury no guide to form a judgment.

The patent of the plaintiffs makes no reference to the position and character of the slag-spout or slag-eye, as called in Karsten's

description. Besides, there is no patent of the plaintiffs or others on a common furnace or on the place or mode of drawing off the slag.

The process of drawing the metal from the furnace by means of the opening pictured in his plate 860 is just as easily applied and used with the slag-spout or opening on the opposite side as the opening described in the patent. The patent has no reference to the slag or mode of tapping it, and any such application to plaintiffs' patent is equally applicable to Karsten's process.

XV.

The seventh instruction (third on page 148) is a mere statement of the pleadings and issue, and was just as proper to be given for the plaintiffs as defendants, and was totally immaterial.

XVI.

The eighth instruction (last on page 148) has the same error as others referred to. It says that if the Karsten furnace, according to the description, will not accomplish or bring about the same results in the withdrawal of clean metal, as the plaintiffs' lead-well. The mode, or form, or shape of the Karsten furnace and the lead-well of the plaintiffs are not matters in issue; the patent claimed was not for the lead-well or the furnace, but for the mode of connecting the two by a pipe, in patent, and a covered eye or opening, described and figured in plate 860 of Karsten.

XVII.

The ninth instruction (page 149, top) that the changes in the mechanical arrangements and proportions of the furnace, however unimportant they may appear, if they produce a useful and beneficial result, and substantial improvement in the art of smelting, such changes, with the beneficial results attained, will support the plaintiffs' patent." Surely the plaintiffs' attorney could not have been in earnest in asking such an instruction as this. The plaintiffs claimed no patent for new mechanical arrangements

on proportions of a furnace. They claimed that their connecting tube, by which the metal ran from the sump or bottom of the furnace into an outside basin of a proper height, was new and useful to any common furnace. They neither made nor claimed any new or useful mechanical arrangements on proportions of a furnace.

XVIII.

The tenth instruction asked the court to charge the jury that if the model presented by the defendants, claimed by them to be like figure 860 of Karsten's Atlas, and described on page 166 of Vol. 5; and if the jury find from the evidence that this model is not like said figure in all the essential and material details, they should not consider it in the case. This instruction is a contradiction in terms. It asks the court to instruct the jury to compare the model with the figure, and if it was not like it in all essential and material details, they should, after comparison, reject. There was no evidence tending to show that the model used in the trial was different from instructions. Frank Faure is the witness relied upon. In his evidence (page 115, second question after 228), in his direct examination, he says: "This model seems to be very nearly correct, according to this drawing."

The Court: "It is conceded that it is made a little smaller, inadvertently;" but the model might, as to the size and proportions, have varied indefinitely from the plate, but if it gave the plan of drawing the melted metal from the bottom or crucible of the furnace correctly, the jury should have not only considered it, but have been controlled in their finding by it, if the case should have been submitted to them.

We have presented these models and drawings to the court: a model of the plaintiffs' tube and connections with a furnace and lead-well; a model of the defendants' furnaces and connection with a lead-well, and a model of the Karsten furnace and connection with a lead-well. We operate those models before the court with mercury instead of liquid lead, and they all drive the liquid from the sump or crucible of the furnace to the lead-well in precisely the same way, and by the same principle of hydrostatic pressure.

XIX.

The plaintiffs' eleventh instruction (page 149): Defendants rely on figure 860, plate 41, Karsten. If the furnace claimed to have been operated by the defendants was not substantially the same as the description, and did not, without material changes, produce the same results as the plaintiffs' lead-well, the jury should find for the plaintiffs.

This instruction is still harping on the furnace and lead-well on which the plaintiffs claimed no patent, on which they show by their plans of a furnace in use, they had no patent. Besides, the instruction asked the court to charge the jury right in the face of the evidence: If there was anything proved in this case to the satisfaction of a court or jury, it was that the defendant, J. B. Grant, built a furnace according to the description and plan of Karsten, and worked for some days in the presence and under notice of four or five witnesses.

Seven or eight witnesses swear they don't believe it could be done; but J. B. Grant, James, Smith, and Beiger, swear *he did it.*

The testimony of these witnesses that Grant did it is of more weight than a thousand who say he could not do it. And these various witnesses who declare their belief that it could not be done, all say that it was because of the proportions and size of the furnace or nature of materials named by Karsten; not that the opening of such a furnace would not discharge the metal into the forehearth or lead well by an opening or covered eye connecting the two vessels.

XX.

The twelfth instruction asked (page 149, bottom of page): the court to charge the jury that the figure 860 in Karsten was not sufficient to constitute a defense in this case.

The court construed the figure 860, as described in Karsten's, as sufficient; and refused to give such charge. The court construed the foreign publication properly, and should have given, as he did,

the contrary instructions. The instruction is also bad, because it does not include the specifications or references to the plates.

XXI.

The thirteenth instruction (page 150) asked the court to instruct the jury that they are the judges whether or not the automatic tap is like the so-called "Karsten fore-hearth" in its objects and beneficial results.

The plaintiffs claimed no patent on "an automatic tap." Their claim was for a connecting tube by which the metal was tapped or withdrawn from the furnace into the adjoining basin or fore-hearth. The fore-hearth in Karsten's was the outside basin of the patent.

The court was the judge whether the patented tube and the covered eye or opening described in Karsten's are alike, by comparison of the two. The instruction asked for nothing else but that the court should transfer its duty to the jury.

XXII.

The fourteenth instruction asked the court to instruct the jury, that the measure of damages was the plaintiffs' annual license, and that a fractional part of a year was to be counted as a whole year.

The true measure of damages has been settled to be the actual damages sustained by the plaintiffs for the time the patent was actually used by the defendants.

WHIT. M. GRANT,

For Defendants in Error.

118-25

FILED
FEB 15 1886
JAMES H. McKENNEY
CLERK

IN THE

SUPREME COURT OF THE UNITED STATES

OCTOBER TERM, A. D. 1885.

WINFIELD SCOTT KEYES AND ALBERT ARENTS,
Plaintiffs in Error.

vs.

JAMES GRANT AND JAMES B. GRANT,
Defendants in Error.

ARGUMENT FOR DEFENDANTS IN ERROR.

E. T. WELLS,
THOMAS MACON,
B. T. McNEAL,
for Defendants in Error.

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ARGUMENT FOR DEFENDANTS IN ERROR.

May It Please the Court:

This suit is brought to recover for the infringement of a patent issued to plaintiffs in error on the 28th day of November, A. D. 1871, for "an alleged new and useful improvement in furnaces for smelting lead and other ores," (page 26, 50*, printed Record) and the averment in the complaint is "that said plaintiffs are now and were before and at the time of the making and issuing of the letters patent hereinafter mentioned the true, original and first inventors of a certain new and

useful improvement in furnaces for smelting lead and other ores, which was not known or used before such invention and discovery" (page 1, 2*, Record); while the claim and application filed by plaintiffs in the patent office are for "the method of tapping or withdrawing molten lead or other metals from a smelting furnace by means of the basin 'B' and tube or connection 'C' in combination with the furnace substantially as shown and described" (page 28, 55*).

Defendant in error denied the utility and novelty of the supposed invention, and pleaded that the same had been described in a certain printed publication prior to the date of the alleged invention, to-wit: in "The Metallurgy of Lead," by John Percy, published in London, England, in 1870, and "System der Metallurgie," by Dr. J. B. Karsten, published at Berlin, Prussia, in 1831-2 (p. 18, 33*).

From the testimony in the case as to the state of the art in and prior to 1870, it is seen that the furnace drawn and described and attached to plaintiffs' specification was in common use; that in all such furnaces there were two openings through the walls of the furnace for the introduction of air, called tuyeres; that below these was another opening called the slag eye or tap, through which the slag and matte were tapped out at intervals, or were allowed to flow continuously, at the option of the smelter, while at the bottom of the furnace there was still another tube, connection or channel, communicating with an outside basin into which the lead or other principal product of the furnace flowed from the interior of the furnace, from which outer basin the metal was removed in any way chosen by the workmen. This

exterior basin was sometimes stationary, and at other times removable when filled; in the latter case it was removed to such place as was convenient, and emptied. This last tube or channel was always closed with a pin of charcoal or with clay, except when the metal was to be withdrawn from the furnace, when it was removed with a pointed bar of iron, and again filled when a sufficient quantity of the metal was withdrawn. The orifice through which the slag and matte escape is called the slag tap, and that through which the metal is withdrawn is called the metal tap. The material of which the furnace was built was brick or stone.

The lower part of the furnace below the slag tap was called the crucible, and the molten products of combustion arranged themselves in the furnace in the order of their specific gravities.

In smelting plumbiferous substances it is shown that lead melts first, and the substances out of which the slag is made melt last.

The specific gravity of lead is three times that of slag and twice that of matte.

The blast used in the furnace exerts upon the mass below it a pressure about equal to that of one inch of lead.

It appears that before and until about the year 1867, in this country, furnaces were much smaller than they are at the present time, and that in Europe they still adhere to the smaller ones.

Until about 1867, furnaces were more perishable than now, the action of the intense heat found necessary to success in smelting soon destroyed them; but in that year one Pillz invented what is called a water jacket,

which is an iron casing enclosing the furnace, between which and the outer wall of the furnace water is kept constantly circulating.

Witnesses made use of a few terms peculiar to the art, and defined them, which we will recapitulate here:

Matte is a product of smelting, and is a sulphide of iron, and may or may not be valuable.

Speiss is a sulphide of arsenic and iron, and is worthless.

Brasque is a composition of fire clay and charcoal or coke dust.

Sows or Bears are accretions of matte or speiss which by adhering to the sides and bottom of the crucible choke it so as to interfere with the smelting operations.

Fore-hearth, Foresump, or Lead Well, is the exterior basin into which the molten lead flows from the furnace.

Further, the purpose and object of the operator of the furnace was to so arrange the furnace and so conduct the process of smelting as to draw from the furnace the valuable products of smelting separated from the worthless products.

It is also made plain by the evidence that molten lead, or a mass of molten metal in which there is a large proportion of lead, rapidly oxidizes when exposed to the atmosphere, and that among the Germans, at least, when they allowed their molten lead to flow from the furnace into an exterior basin and remain in such basin for any considerable time, they covered the surface of the lead with either the slag, which they allowed to run on or over the top of the basin and incrust, or by covering it with some other material, and when the workman de-

sired to remove the lead from the exterior basin he removed the covering and dipped the molten lead from such basin.

But while it is true that in the majority of cases the smelting furnaces were constructed as above described, there was as early as 1831-2 a furnace used in which the valuable products of the furnace were not tapped or withdrawn from the furnace at intervals, but in which these products flowed continuously from the crucible into an external receiving basin through a tube, connection, or channel, and rose in said basin to a level with the same material in the crucible by force of the well-known law of the equilibrium of fluids, and in which furnace there was a slag tap through which the slag flowed either continuously, or was tapped at intervals at the election of the workman at the furnace. In this furnace, as in all others, the molten masses arranged themselves in the furnace according to their several specific gravities, and flowed and rose into the outside basin above the channel of communication by the law above stated. In this furnace the slag tap or eye was just above the external basin, so that if the slag flowed continuously it would run into such basin if it were not full of a heavier material, or on top of such metal in the basin if it were full, and flowed off to such place as the workman saw fit to conduct it.

In the description of this furnace—which is called a sump furnace—the author says that the slag can be allowed to cool on top of the lead basin, and then be thrown off and the clean metal be dipped out, or the clean metal can be drawn off from such basin through a

tap or tube into a second basin or receptacle, leaving the skim or covering of slag on the top of the metal in the basin. It is explained that the slag is allowed to run on the surface of the contents of this basin for the purpose of preventing oxidation; moreover, this is called a lead furnace, and it is said that in smelting where but a small quantity of slag is produced, the upper slag tap or eye may be dispensed with and the slag can be allowed to run out of the crucible through the tube which conducts the lead into the outer basin.

It is further shown by the evidence that the formation of "sows" or "bears" is the result of improper combination of ores constituting the charge to be smelted, and that with such improper combination these accretions will form in any furnace.

It also was shown, and not controverted by plaintiffs, that a furnace with their supposed invention cannot be operated in the smelting of iron, copper or other ores not carrying a large percentage of lead, because lead is the only metal whose fusing temperature is sufficiently low to allow its being kept in a fluid state in an outside basin, the heat of the interior of the furnace not being sufficient to keep any other metal fluid.

In this state of the art, plaintiffs apply for and get a patent for their alleged invention, which consists solely in using an exterior basin, which was old, a tube or channel, which was old, and so applying them to a furnace, which was old, as to bring into play a well known physical law which had been used with the same appliances for the purpose of balancing fluids time out of mind.

II.

On the case, the first question is, was the device or method the result of the application of the "inventive faculty," or a mere obvious mechanical contrivance. Defendants insist that there was no invention in plaintiffs' supposed improvement, because the law they utilize was well known, because the mechanical structures used were old, and because the combination of the structures was in use for ages before the date of the patent. The syphon had been in use a century at least before 1871, for the passage of fluids over a point higher than that which either end of the syphon occupied. The common coffee or teapot was a Keyes and Arents' attachment in which the coffee or tea rose in the spout to a level with that in the vessel, while the sediment sunk below the point of intersection of the spout with the body of the vessel, thus leaving clear the decoction which is discharged from such spout. It required no inventive faculty to apply the same structure to a smelting furnace so as to obtain the regulus from this spout while the sediment, that is the slag or matte, was kept on top of the mass of valuable products. The only difference between the action of the smelting furnace with plaintiffs' attachment and that of a coffee or teapot is that in the former case the refuse matters float on top, while in the latter they sink and the valuable product swims on top.

But the test of invention seems to be in the *benefit to the "trade."* The question being, is the result produced something valuable and new? In this case, tried by this rule, the inquiry is, did the plaintiffs produce something new and useful by the use of old means, or did they by the use of new means produce an old result more cheaply?

That they do not bring themselves within either of these conditions is obvious. Clean lead in smelting had long been produced before their alleged discovery, and the means used by them to produce it were old. Thus we have neither new and better means, nor a new and better product.

Patents are issued for a new process or method only when that is produced by new structures which in themselves are better or cheaper than those before in use; or if old structures are used in a new way the product must be better than that obtained before, or its production must be cheapened. And if the ground for a patent is confined, as in this case, to a mere change in the combination, juxtaposition or relation of the parts of a machine before in common use, such combination must not have before been known and used in other machines or implements for an analagous purpose.

Bean vs. Smallwood, 2 Story, 408-410.
Treadwell vs. Parott, 5 Blatch. 369.
Stimpson vs. Woodman, 10 Wall. 117.
Brunton vs. Hawkes, 4 B. & Ald. 540-550
Losh vs. Hague, 1 Webs. Pat. Cases, 207.
Howe vs. Abbott, 2 Story, 190-93.
Bush vs. Fox, 26 Law & Eq. R. 464.
Harwood vs. The Great Northern Ry. Co. 11 House of Lords Cases, 654.

In this case, admitting all that is claimed for plaintiffs, the occasion only is new, the devices or tools are old; their application to other machines or structures is old; the principle upon which the combination acts is not only as old as the earth, but has been known as far

back as history goes, and the result produced is as old as lead smelting, namely: the production of clean lead in a molten state. This case comes completely within the illustration put by Ld. Abinger in Losh vs. Hague, *supra*, of claiming a patent for the discovery that spoons could be used as conveniently for eating peas, as before they had been for eating soup, and of Mr. Justice Story in Howe vs. Abbott, *supra*, of a coffee mill used for grinding corn.

The utility is not established by the evidence. It is shown that a great many smelters use this arrangement of the metal tap, but that is not by any means conclusive. It is also shown that a great many do not use the plaintiffs' arrangement of the tube. The witness, Giest, who since 1878 has been in the management of a large smelter at Pueblo, Colorado, never used the inclined or slanting tap though he paid $2,000 for the right to use it (p. 75, 147*, Record). They are not in use in Germany, or were not in 1876. The principal useful result claimed for plaintiffs is the prevention of the accretions in the operations of smelting, called "sows" or "bears." This claim is shown to be wholly unfounded. The testimony of J. B. Grant and Mr. Giest, as well as other practical metallurgists, explains the cause of these accretions to be the improper mixing of the ores put into the furnace. It is conceded by plaintiffs that the substances out of which these are formed being lighter than lead, cannot either in a molten or solid state sink below the surface of the molten lead in the bottom of the crucible of the furnace; and it is shown that whether this molten mass of the lead in the furnace—called the lead bath—shall be all withdrawn or only par-

tially is wholly in the power of the workman at the furnace. And it is also shown that it is and has long been the practice of metallurgists to put into the furnace bars of lead before it is fired up, so as to always have a sufficient quantity of lead at the bottom to prevent the descent into the crucible of the material of which these "sows" are formed.

Plaintiffs contend that by this method a sufficient quantity of lead can always be left in the crucible to prevent the descent of such masses as form accretions into the crucible, because the depth of lead in the lead well always shows the depth of lead in the furnace. This is not true; because as the lead sinks in the furnace by dipping from the lead well, the matte and slag will sink down upon it and force it up into the tube and basin. This is shown by the testimony of Grant (at page 34, 69*), and Geist (at page 76, 148*), Smith (at page 70, 139*). Any tube which taps the furnace at the bottom will allow all the fluid lead to be withdrawn, whether it be at right angles with the furnace and basin, or inclined to these. Hence, the defendants' improved upon the plaintiffs' arrangement and tapped the crucible twelve inches above the bottom of the furnace so that they always had one foot of lead bath below the intersection of the tube with the crucible.

Nor is the arrangement of plaintiffs' useful in saving time in withdrawing the lead; both Grant (page 37, 74*), and Geist (page 74, 146-147*), testify to the contrary, and both negative the claim that it dispenses with skilled laborers.

In short, it is now, and for ages past has been, in the power of the workman about the smelter to draw the waste material through the metal tap at the bottom of

the crucible or from the slag tap, at his election.

Furthermore, the witness Geist (page 75, 147*) says he never used the inclined tube, but the horizontal channel; and Smith (at page 73, 144*) says of plaintiffs' tube and basin, that "They are various. Messrs. Keyes & Arents, and probably every other smelter, have their ideas, and make them accordingly." Mr. J. B. Grant (page 34, 69*) says that in their furnanaces the tube is a great deal larger than that described in plaintiffs' specifications, and does not enter the crucible at the bottom, but at a point about one foot above the bottom. This improvement upon plaintiffs' arrangement was made because the witness says that careless workmen would sometimes dip all the lead from the crucible through the outside basin, and the slag and matte would necessarily sink to the bottom of the crucible and flow into the inclined tube and basin.

It was to remedy this that defendants improved on plaintiffs' position of the tube. It will be noticed that plaintiffs insist that this improvement is merely mechanical, that it is obvious to any mechanic, and is within the range of their invention, and was suggested by it, because of the terms "suitable elevation" in their specification as applied to the outside basin "B."

We suppose fairness requires us to concede this position, for the change made by defendants in the point at which the inclined tube enters the crucible is not the result of the inventive faculty, but is merely formal, and we confess that for such improvements, or for the result of such changes, a patent will not issue. But the fact that a furnace such as is used by the witness Geist, that is, with an outside basin connected with the

crucible by a horizontal tube or channel through which the valuable product flows and rises in such exterior basin to a level with the same product in the crucible, while the waste product is tapped from an opening higher in the furnace, shows very plainly that there is no utility in the supposed invention. And this is conclusively shown by the testimony of the plaintiffs; for plaintiff Arents says (page 114, 226*) that any furnace having an exterior receiving basin with a slag eye, or tap, on a different side from the basin and from which the clean molten metal flows into such basin and rises by hydrostatic pressure, is plaintiffs' invention. And plaintiff Keyes (at page 146, 281*) says that the only new thing in their invention is the slant in the tube, and as it is shown that the horizontal tube is as efficacious as the slanting one for the sole purpose for which the plaintiffs' alleged invention is said to be useful, we insist there is no utility in it.

III.

The plaintiffs' device is not novel, and is a mere copy of a furnace old and in general use, described in printed publications both in this country and Europe thirty years at least before the date of plaintiffs' application for a patent, and known and worked by plaintiff Arents before his migration to this country.

To place these facts beyond question, we will quote from the 3d volume of "Karsten's System der Metallurgie," pages 316, 317, 318, 319 and 320. from which a clear understanding of the kind of furnaces then in use as well as a conception of their construction and the functions of the several parts, may be had. We quote page 316: "A distinction is made between shaft furnaces

with an open and those with a closed breast. This distinction is carried out completely only in iron smelting furnaces.

"Strictly speaking a shaft furnace with a closed breast includes only those furnaces in which the crucible is entirely on the inside, and from which the molten material is tapped off from time to time.

"Generally speaking, however, those shaft furnaces in which the slag runs continuously and the metal and matte are tapped off at intervals, and also those in which the metal, matte and slag run continuously through a hole in the front wall, are reckoned as furnaces with closed breasts. Open breasted furnaces are those in which the breast is partly on the inside and partly in front of the fore wall of the furnace. The word "hearth" is ussd to designate different objects. Sometimes the sole or bottom of the furnace; sometimes the crucible on the inside of the furnace, and sometimes the basin into which the molten masses are drawn off are designated by the word "hearth."

"The word 'hearth,' however is used chiefly to designate the space in the furnace where the molten masses are collected.

"A hole in the front wall of the furnace kept open continuously is called the eye. If opened and closed at intervals, it is called the tap hole or *stich*

"A spur is a channel which leads from the eye of the furnace to a vessel or basin into which the molten contents of the furnace are emptied-" * * *

Page 318: "The fore-hearth is that part of the cruicible projecting in front of the forewall of the furnace.

"Crucible furnaces are those shaft furnaces in which

the crucible is entirely on the inside. They are divided into eye crucible furnaces and tap crucible furnaces.

"The former have an eye in the front wall from which the slag flows continuously, the metal and matte being tapped off at intervals into basins. The tap crucible furnaces are those in which the metal, matte and slag are all tapped off from time to time.

"Sump furnaces are those shaft furnaces in which the crucible is partly in the furnace and partly in front of the furnace.

"The slag runs off continuously over the fore-hearth. The metal and matte are tapped off into receiving vessels or tap basins. Sometimes the sump furnaces are not provided with tap basins and the metal is then dipped with ladles direct from the fore-hearth. * *

"Spur or channel furnaces are shaft furnaces without a crucible; the molten contents flow through the eye directly from the furnace hearth into receiving vessels. These different furnaces can be more advantageously studied from drawings than from written descriptions."

Page 319: "In some countries the crucible furnace is preferred, in others the sump furnace. It is not advisable to use the channel furnace where clean metal is produced. With this furnace the metal is not protected from oxidation. It is used chiefly in smelting copper ores with a view to producing copper matte.

"The drawings, figures 461-463, represent an eye crucible furnace. The slag runs continuously through a hole in the front wall. The metal and matte are tapped off at intervals through a hole in the side of the crucible.

"The drawings, figures 464-466, represent an eye crucible furnace which differs from the former in that the tap hole is in the front wall and at the bottom of the crucible.

"The drawings, figures 467 to 479, reprepresent a tap crucible furnace. The metal, matte and slag are tapped off from time to time into receiving basins.

"The drawings, figures 470 to 472, represent an eye crucible similar to the one represented by drawings, figures 464 to 466; it is provided with two tap basins. The slag also passes through a basin for the purpose of allowing any particles of metal and matte mixed with it to settle."

Page 320: "The drawings, figures 473 to 475, represent a sump furnace with a covered eye in which the brasque under the front wall divides the sump into two communicating vessels. The slag runs off continuously through the eye between the bottom of the front wall and the top of the brasque partition. This arrangement is used when it is desired to dip the clean metal with ladles from the fore-hearth instead of drawing it off into tap basins.

"The drawings, figures 476 to 478, represent a sump furnace with an entirely open breast, in which the slag passes off immediately over the fore-hearth. The drawings, figures 479 and 480, represent a sump furnace with a covered eye and with a tap basin into which the metal and matte are tapped from the fore-hearth. This furnace might be regarded as a channel furnace by simply considering the short canal or eye which connects the sump under the shaft with the fore-hearth as a channel. But by means of this short canal or eye the sump and

the fore-hearth stand in combination with each other, as a pair of communicating tubes or vessels, consequently it is a sump and not a channel furnace. The slag may pass through the covered eye into the fore-hearth, or through a open eye above the fore-hearth, the latter being used exclusively for the slag. In smelting operations where little or no slag is produced, the upper eye is dispensed with entirely."

The drawing of the furnace given in Vol. V, page 166, plate 41, Fig. 860, would be the figure given in plaintiffs' specification if the "covered eye," as it is called, were inclined, instead of at right angles, to the crucible and receiving basin. In the significant language of Mr. Keyes, the "slant" is all that is new in their arrangement of these parts of the old smelting furnace.

That this "slant" was not necessary to bring into action the law of the equilibrium of fluids, or as witness called it, the law of communicating vessels, and that it was as well utilized by the means of a tube at right angles with the two vessels, plaintiffs admitted.

Arents, (page 101, 201*) says in substance that if the fore-hearth or lead well or outside basin described by Karsten, and shown in figure 860, were placed at a suitable elevation, and the wall between the two communicating vessels were made stronger, and the dimensions of the furnace were changed somewhat, the same result would be produced as in plaintiffs' arrangement. To quote, "put the slag eye here to one side and you have a furnace like ours, because then you combine an ordinary furnace with a basin on the side in a substantial manner."

The same witness in the same connection, and immediately following, says that any attachment to a furnace so constructed that the lead flows into a fore-hearth or lead well in a clean state and rises to a common level in the outside with the contents of the inner crucible, and the slag is withdrawn away from and at another side of the furnace from where the lead well is, is plaintiffs' invention.

At page 143, 276*, Keyes, in answer to this question: "Suppose it to be true that the defendants tap from the bottom with a straight channel into an outside lead basin from which the lead rises practically to a level in the lead basin with the lead in the crucible, are they using you device or not?" Says, "With an elbow the level of the lead higher up, he is using an inferior device."

Question. "Is it your device."

Answer. "I contend it is."

Q. "From your understanding of the specifications, mechanics and metallurgy, he is using your patent."

A. "He is using an inferior variety; yes, sir."

At page 144, 278,* this question was put to witness Keyes:—

Q. "If the old fore-hearth were carried up in form of a wall to a level with the lead in the crucible, what would be the difference in the old and new method?"

A. "There would be none if the slag were allowed to run off in some other way; but by our device the fore-hearth being raised to a level with the lead in the crucible and the slag being drawn off through a slag eye, constitutes the difference between the old and the new method. We deny that the process was ever used before our invention."

Page 145, 279* :—

Q. "You say the principle upon which the Karsten furnace acts—the principal of connecting vessels—is the same as the Keyes and Arents?"

A. "Exactly."

Q. "The metal ran into this outer well to the same level that it ran into the crucible?"

A. "Yes."

Q. "Through this eye?"

A. "Yes."

Q. "The front wall came down to the bottom of the crucible?"

A. "No, sir; that was an artificial prolongation made of brasque."

Q. "There was a wall which came down to separate the crucible into two vessels instead of one: through that there was an eye made to serve as a communication between the two vessels?"

A. "Yes."

Q. "The metal flowed through this eye and rose to an equal height in the basin?"

A. "Yes, sir."

Q. "That was hydrostatic pressure?"

A. "Yes."

Q. "The slag flowed through the slag eye above the lead basin if there was enough lead in the crucible to cover this eye?"

A. "No; not until the lower eye was covered with matte; after the lower eye was covered it run through the slag eye."

A. "From this the slag flowed through the lower eye or not, depending upon whether they put in enough metal to produce lead sufficient to cover the lower eye before any slag formed."

A. "Essentially it did."

Q. "But whether or not the slag did flow through this lower eye depended upon the choice of the man

who smelted it?"

A. "Yes."

Q. "If Karsten had seen fit to make the slag eye on the side of the furnace instead of its being in front, would he not have had your invention; you say he would not; what is the difference?"

A "He would have had a modified form, if he had made the brasque of imperishable material, removed the slag eye, and put it around to the side, he would have a modified Keyes and Arents' furnace."

Q. "When a furnace is constructed as this Karsten furnace is, with a tap attached to this slag eye so as to conduct this slag away, would the lead well on this furnace act badly?"

A. "No."

Q. "Would it act as this of yours so long as this lower eye was kept open?"

A. "Yes; most assuredly."

Page 146, 281*:—

Q. "You applied for a patent?"

A. "Yes, sir."

Q. "The only thing new is the slant?"

A. "If there be anything new—any part or portion of it which is absolutely new—it is the slant."

Q. "Did you say that—stand by that?"

A. "Of course."

In connection with this testimony—it may be called the contessions—of plaintiffs, the testimony of Dr. John Percy, of England, seems to us conclusive of the question. At page 82, 160-161*, he says: "From 1851 to 1879 I was lecturer on metallurgy at the Royal School of Mines, London, but resigned that office in December, 1879. * * * I am the author of a treatise on the metallurgy of lead, published in London in 1870, and of

a treatise on the metallurgy of silver and gold, published in London in 1880.

"I have read Exhibit "A," and am of opinion that what Messrs. Keyes and Arents claim as their invention is not novel. My reasons for that opinion are as follows: 1st. Karsten in the 5th volume of his system 'Der Mettallurgie,' published in 1832 in Berlin, p. 166, describes a furnace for the smelting of plumbiferous substances, in which the reduced lead flowed from the bottom of the furnace into an external cavity or basin and rose therein to the same level as the lead accumulated within the furnace.

"In the atlas of plates illustrative of Karsten's treatise, engravings showing the construction of such a furnace are given, and of these, No. 860—which is a vertical section on the medium line from front to back—demonstrates, in my opinion, that by suitable management exactly the same results may be obtained as with the furnace claimed as the invention of plaintiffs. The differences between the two furnaces is in the relative dimensions of the channels of communication between the hearth and the external cavity or basin. In Karsten's furnace that channel is much wider, that is, measured horizontally, from side to side, than in the plaintiffs' furnace, in which it resembles a round pipe in shape. Slag, rugulus and speiss, which may be produced in smelting, would necessarily float on the molten lead within the furnace owing to their specific gravities being much lower than that of molten lead, and my opinion is that in Karsten's furnace such substances might, by suitable management, be effectually prevented from escaping into the external cavity or basin; but sup-

posing that any or all of these substances should pass into the external cavity they would rise to the top of the molten lead therein accumulated and not injure its quality; for while within the furnace, they must, as previously intimated, have floated on the molten lead in the hearth and produced their greater effect upon that lead, whatever that effect might be."

Pressed by these difficulties, the plaintiffs, in their testimony, asserted that a furnace built upon the scale given by Karsten was unsuited to produce the valuable products of smelting separated from the waste material, because the dimensions were wrong. While they adhere to the statement that the distance between the slag eye and the covered eye through which the metal flowed in the furnace described by Karsten was too short to prevent the slag from pressing out all the heavier material and flowing into the fore-hearth or lead basin, or lead well, they admitted that if the slag eye and tuyeres were raised a few inches higher the objection would be obviated. That is, that if by changing the dimensions of the furnace so that a lead bath of sufficient depth would be created to support the pressure of the slag, blast, and superincumbent mass of ore, at such height as that the slag would flow out of the slag eye, and the slag by any contrivance was prevented from flowing into or over the lead well or fore-hearth, the furnace would be theirs, so far as results, means and principles of action are involved in their invention.

This admission is fatal to plaintiffs; for it is clear not only from their testimony but from the description given by Karsten, and the model introduced by defendants,

that the modification of this furnace insisted on by plaintiffs in order to constitute their invention, was purely formal and mechanical.

It is not a little inconsistent that plaintiffs should claim that defendants in enlarging the tube and inserting it in the furnace one foot higher than they the plaintiffs did, were still using their invention and infringing their patent, and forget that they were bringing themselves within the reach of the same principle, as applied to their modification of the Karsten furnace. If the change in the application of the tube to the crucible made by defendants, the effect of which was so different from that produced by plaintiffs, and so much more beneficial, in that there is always a bath of lead one foot in depth which cannot escape from the crucible, and below which no "sows" can form, can not be patented, because substantially plaintiffs' invention, how can plaintiffs be entitled to a patent for so slight a modification of the Karsten furnace as is involved in slanting the eye-tube or channel? Such a change the merest house carpenter could perceive and construct. It is almost certain that plaintiffs had Karsten's furnace in mind when their pretended invention was made, when they slanted the eye and placed the basin to one side of the furnace instead of in front, as in Karsten's, and at a "suitable elevation" above the inside crucible; more especially so in view of the fact that plaintiff, Arents, is a German by birth, educated at Clausthal, and the university of Berlinghen, as a metallurgist, and practiced his profession in that country four or five years before he came to this country (page 28, 56*). And at page 103, 206-207*, he says: "They have used this sump furnace,

figure 860, in the same work at Clausthal where the other furnaces are, but without that eye, and for revivifying lithrage only, that is all. I have worked on that furnace myself."

It is true he says this furnace was used tor revivifying lithrage—oxide of lead—but here we have the spoons for eating peas, and the coffee-mill for grinding corn, and the scissors for cutting silk, again.

It makes no difference for what purpose it was used, or what sort of ores or metals were smelted or melted in this furnace. Arents saw it used in smelting litharge, a substance composed of lead almost entirely, and in which the percentage of slag is very small, the very case given by Karsten in which the upper slag eye might be dispensed with, and the slag allowed to run into the fore-hearth through the lower or covered eye.

Taking each change in the construction of the Karsten furnace insisted on by plaintlffs as necessary to convert it into their invention, and examining it by itself, it is quite apparent that each one is obvious to any practical mechanic. First, the fore-hearth, lead well or outside basin—for they are convertible terms—is too close to the slag eye; the consequence of which is that there is not a sufficient depth of lead in the crucible to sustain the slag above it and the pressure of the blast. Now it is shown that the blast exerts a pressure equal to the weight of about one inch of lead, and that one inch of lead will balance three of slag, or two inches of matte. In the Karsten furnace, the outside basin is eleven inches deep, and its top is on a level with the slag eye, while the covered eye through which

the lead flows is three inches deep, leaving seven inches between the top of that eye and the bottom of the slag eye. If upon putting the furnace to work the workman found that these two eyes were too close together, he has no more to invent in order to change their position so as to produce the result he is seeking, than he would to find a tape line or square with which to measure to the point at which he would place another slag eye.

Second. It is said that the slag eye as represented by Karsten is too large, as he described it as an "always open eye;" that the furnace would blow out and freeze up." It certainly would not require the exercise of the inventive faculty either to stop this eye and tap the slag at intervals, or to so reduce the dimensions of it as to remedy the defect.

Third. It is said the slag eye being immediately above and on the same side as the lead well, must discharge slag into the lead well. But it is not denied by plaintiffs that a spout might easily be attached to the slag eye so as to prevent this discharge of slag into the lead wrll; or that the lead well might be set on another side of the furnace. Still plaintiffs contend that if either of these changes is made, the furnace will be practically a different one from that described by Karsten. But that these changes could not be called invention in the state of the art any time within the past century is too clear for argument.

Lastly. It is said that the portion of the Karsten furnace which was composed of "brasque," and which served as a breast to the furnace, and through which the lower eye was made, was less durable than the other

portions of the walls, and therefore it was different from the invention of plaintiffs. It is true that furnaces are now built of stronger material than "brasque," but an improvement in the materials of which a machine is constructed is not the subject of a patent.

Hotchkiss vs. Greenwood, 11 Iowa, 246, 266.
Heald vs. Rice, 104 U. S. 755.

Besides, if it were, plaintiffs do not claim to have invented an improvement in the material used in building smelting furnaces.

The result of plaintiffs' contention on this point is that having changed the furnace described by Karsten, by means which would occur to anyone who had any practical knowledge of mechanics, they are entitled to a patent.

But the plain conclusion from the evidence is, that the Karsten furnace needed no changes to produce clean lead in the fore-hearth by the operation of hydrostatic pressure. The defendants built a furnace, the model of which is in evidence, according to fig. 860, plate 41, page 166, Vol. V. "System of Metallurgy," and by the scale there given, and worked it for sixty or ninety days continuously until their works were burned in May, 1882. That it was as efficacious in the production of clean lead as those to which were attached plaintiff's alleged invention was so overwhelmingly shown that it was not controverted by plaintiffs. All that was attempted by them was to testify that in their opinion this furnace could not have been built on the scale given by Karsten.

To make the identity of the two furnaces more clear, defendants attached to the same furnace the device of